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THE ENGINEERING MAGAZINE,

PUBLISHED MONTHLY. 140-142 Nassau Street, New York, U. S. A.

AUTHORS AND PAPERS FOR APRIL, 1907

ERNEST JOHN MUNBY *(New York and Panama. A Contrast in Engineering Achievement)*—Educated at Bedford Grammar School, Rugby, (1886-1891), and Stevens Institute of Technology (1897); from graduation until May, 1898, asst. supt. Winrow Gold Mining & Milling Co., Alma, Col., and until December, 1898, engineer for the North American Gold Dredging Co., erecting and helping to run the first two gold dredges used in America; 1899-1900, engineer and asst. manager North Borneo Gold Syndicate, dredging and prospecting in the jungle; May-October, 1900, chief asst. and later chief engineer U. S. cold-storage and refrigeration works, Manila, P. I.; 1901-1904, with Gardner Electric Drill & Machinery Co., Denver, Col.; January, 1905, to May, 1906, engineer for Auriferous Pyrites By-Products Co., London; then for six months asst. mechanical supt. for S. Pearson & Son, Inc., installing, altering and repairing shields, compressor plant, hydraulic and electric machinery, etc., on the East River Tunnels, and since then constructing for the Hudson Companies in four different tunnels, with and without shield, in rock, made ground, sand, and mixed ground. Member Inst. M. E., Am. Soc. M. E., associate Inst. M. & M.

JOHN E. HARDMAN *(Cobalt, Canada, the New Silver-Mining District)*—Born in Lowell, Mass., 1856; graduated from the Massachusetts Institute of Technology in 1877 as mining engineer, with degree of S. B.; afterwards studied a short time in England and Germany; went to Leadville in 1878; built the first smelting works at Red Cliff (now Eagle City); was on the staff of the U. S. Geological Survey in 1880; has had practical experience in gold, silver, copper, lead, and antimony mines, in Georgia, North Carolina, Nova Scotia, Colorado, Montana, Ontario, and British Columbia; was professor of mining and metallurgy at McGill University, 1895-96, resigning to act as consulting mining engineer for Canadian and English companies operating in Canada and the United States. Is a member of the American Institute of Mining Engineers, the North of England Institute of Mining and Mechanical Engineers, is a past president of the Nova Scotia Mining Society, and of the Canadian Mining Institute; holds the honorary degrees of B. Ap. Sc. and Ma. E.

H. VON SCHON *(Hydro-Electric versus Steam Power for Industrial Plants)*—Born in Germany, graduating from Berlin in 1869; for thirty years a specialist in hydraulic engineering; several years were spent by him in connection with the U. S. Engineer Corps in surveys of the Great Lakes, but for the last twelve years he has devoted himself exclusively to the designing of hydro-electric power installations. The most important of the many he has planned is that at the foot of Lake Superior, notable as utilizing the largest flow—some 30,000 second feet—while that at Eugenia Falls, Ontario, uses only 80 second feet, but a head of 400 feet. Mr. von Schon has originated a number of valuable features, one of which, the submerged power house, has been incorporated recently in a plant at Patapsco, Md., the entire generating equipment being placed in the interior of the dam, with the spillway water rolling over the power-house roof. He is a member of the American Society of Civil Engineers.

CHARLES U. CARPENTER *(Profit-Making in Shop and Factory Management)*—A graduate of Princeton Universtiy with the degrees of mechanical and electrical engineer, has had a large experience in mining engineering and electrical manufacturing and in the supervision of large manufacturing plants; for some years he was factory supervisor and afterwards head of the labor department of the National Cash Register Company, Dayton, Ohio, U. S. A. Later took a similar position with the Herring-Hall-Marvin Safe Company, rising rapidly to the presidency of the concern.

HOWARD GREENE *(Tendencies and Improvements in Marine Gas Engine Construction)*—Served nticeship as locomotive fitter and machinist in Grand Trunk Railway locomotive works at Point St.

Charles, Montreal; machinist and fitter with Royal Electric Company, Montreal; locomotive fitter and machinist, Canada Atlantic Railway shops, Ottawa; later was connected with department of motive power and with general superintendent's department of the same road. Began journalistic work on one of the New York dailies and shortly after joined the editorial staff of the *Horseless Age,* New York, as a writer on mechanical topics. Continued the same line of work for three years on the editorial staff of *The Automobile,* New York, and later, of the *Commercial Vehicle,* formerly published by the same company. After the separation of the two publications became associate editor of *The Automobile,* relinquishing this post at the beginning of the current year to collaborate in the organization of the Technical Press Bureau.

C. E. KNOEPPEL *(Cost Reduction through Cost Comparison)*—Born in Milwaukee, Wis., 1881. Educated in the Public Schools of Buffalo, N. Y. Spent a year in a technical school in that city. Removed to Oswego, N. Y., and was for two years employed as a moulder in the foundry of the Ames Iron Works. Was employed as draftsman and designer for two years by the Buffalo Forge Company, Buffalo, N. Y., and for one year by the Parkhurst Compound Steam Boiler Company of Oswego. Was later connected with the Department of Expert Systematizing of the Library Bureau, Boston, and has been a student and a specialist in costing methods for six years past. Is at present office manager for Clark Bros. Company, Belmont, N. Y.

REGINALD PELHAM BOLTON *(Present Practice in the Use of Superheated Steam)*—Born and apprenticed in England; served as assistant engineer at the Edgemoor Iron Works and as assistant to Dr. Erasmus Leavitt; has been in practice in New York City since 1895 on the equipment of large buildings, having designed, within the last few years, the equipment of the Bowling Green offices, the Grand Central Station, the Royalton and Lorraine hotels. He originated the vertical system of electric wiring and duplex-pressure hydraulic-elevator system; has been in charge of the remodeling of the Ridgewood Pumping Station for the City of Brooklyn. before and since its incorporation with the city of New York, from 1896 to 1900; associate member of the Institution of Civil Engineers, member of the American Society of Civil Engineers, and of the American Society of Mechanical Engineers.

E. SCHAAF-REGELMAN *(Rare Metals and Minerals and Their Uses)*—Educated in Germany, France and England, having studied mineralogy and metallurgy in technical high schools in Germany and at the University in Paris; followed out a thorough commercial training, and traveled extensively through the more important mining districts of the Continent, studying ore dressing, treatment, and smelting, and managing the commercial business of European manufacturers in chemical and metallurgical lines. For many years has been encouraging American producers to separate the so-called "rare minerals," offering technical advice and a ready market for these valuable by-products which in most cases have heretofore been going to waste.

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The Troy Wagon Works Company

Crawford and West Streets, Troy, Ohio

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

Vol. XXXIII. APRIL, 1907. No. 1.

NEW YORK AND PANAMA. A CONTRAST IN ENGINEERING ACHIEVEMENT.

By *Ernest John Munby.*

$600,000,000 is an underestimate of the engineering work under way in and tributary to New York City alone, exclusive of ordinary building and of Federal expenditures in the harbor. Every yard and pound and dollar of it is proceeding with civil engineers in charge and capable contractors doing the work. Construction three times as great as the equivalent of the Panama Canal is moving steadily and triumphantly to completion and success, and not a hint of inefficiency nor a breath of scandal about it all. If the Administration rejects the methods which the great railways and other constructive corporations have found universally best and most economical, it assumes a heavy responsibility. Here is a standard by which the comparative efficiency of Government engineering and labor and Departmental direction may be tested. The future holds the answer.—The Editors.

At a time when the construction of the Isthmian Canal is engaging so much public interest, the magnitude of the undertaking is apt to overshadow in the popular mind—Nationally, if not indeed locally—the importance of improvements in transportation facilities almost as great in conception and certainly more difficult in execution, which are now proceeding with very little in proportion of advance advertisement and ostentation.

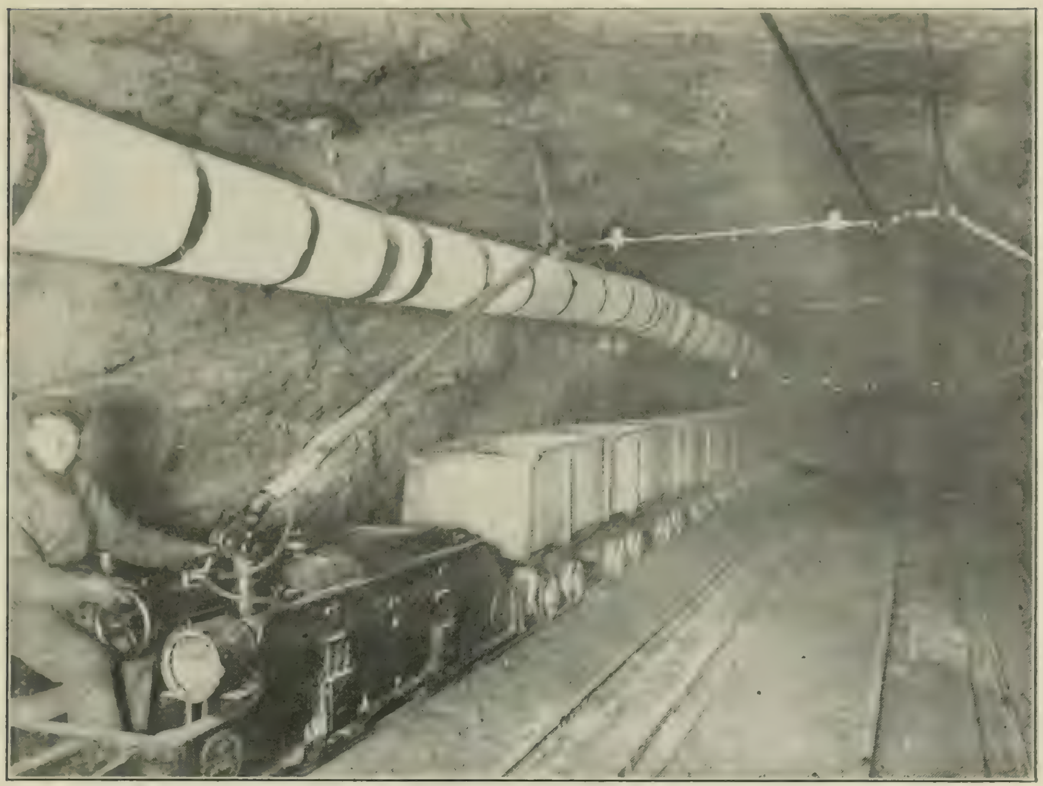
That the dream of great minds, four centuries ago considered visionary but for the past hundred years the ambition of engineers, should be within definite prospect of realization as a National undertaking, is to Americans a source of justifiable patriotic pride and of international interest. The importance to the world's commerce of an interoceanic waterway by which sea traffic can pass between the two greatest oceans without a circuitous voyage around the Horn can hardly be exaggerated. Yet it is scarcely greater than the value, not merely to New York but to the United States at large (considering the prominence of the Metropolis as a seaport and commercial export centre) of the provision of a number of continuous routes for railway and other vehicular traffic connecting Manhattan Island with the mainland by means of tunnels.

And yet it is very imperfectly realized that, with comparatively little notice from the public press though at a cost which in the aggregate will far exceed that of the Panama Canal, sixteen separate tunnels under the wide waterways surrounding Manhattan are in course of construction or actually completed, and will rapidly emancipate New York city from the limitations of its insular position. There are three systems, comprising eight tubes, under the East River; three systems, comprising six tubes, under the Hudson, and one system of two tubes under the Harlem River. And beyond all this, three more systems comprising six tubes between the Brooklyn Bridge and the Battery, two great Subway extension systems with a total of four tubes under the Harlem, and one system of two tubes north of the Williamsburg Bridge, are definitely projected and will be completed long before the Panama Canal, while certainly two more systems under the Hudson and probably others are proposed. The New York Central Railroad electrification and terminal work approximately equals the Hudson Company or Pennsylvania enterprises in total outlay, and the bridges add about $50,000,000 to the grand sum.

Residents of the neighbourhood of Thirty-fourth Street have their attention called to the work in progress by the concussions from subterranean blasting; passengers on ferryboats sometimes observe miniature geysers thrown up by escaping air from some submarine bore; sensational newspapers occasionally turn to the work as promising opportunity for a reportorial voyage of discovery and hairbreadth escapes, to be described in garbled language which uses "caisson," "lock" and "shield" as synonymous terms. But, though articles in technical journals have descibed with dignity and authority the details of individual sections of tunnel or the plant and equipment necessary for their construction, little has been said of the scope and importance in the aggregate of all the engineering work now in progress.

A comprehensive idea of its huge physical scope and economic significance is presented at a glance in the table on page 20.

The conditions under which the work must be conducted at Panama have been carefully and elaborately pre-ascertained and are *all*, with the possible exception of the necessary depth of some of the dam foundations, positively and exactly known; whereas the conditions to be encountered in much of the tunnel work are practically unascertainable. The test borings made along the line of route, both on land and under water, before the initiation of tunnel operations, reveal at



ELECTRIC LOCOMOTIVE WITH TRAIN OF CARS REMOVING SPOIL.

In the Hudson Companies' first tunnel, in rock near New York end. Air pipe leading to bulkhead is seen overhead.

the best with only approximate accuracy the nature of the ground to be encountered in the tunnel itself.

The nature of such excavation as is required for the Panama Canal —the operation of steam shovels and similar powerful machinery—may be observed at the site of the Pennsylvania Railroad's station at Thirty-third Street. But the removal of a similar quantity of material, especially when subaqueous or water-bearing, in the confined space of a tunnel will readily be understood to be infinitely more difficult. For example, in the cross-town tunnels of the Pennsylvania improvements some of the ground is handled by "steam" shovels which however are operated by compressed air, as the emission in any quantity of fumes possibly detrimental to workers is not permitted in underground work. Similarly the use of animal power for haulage is rarely possible, and, man power being impracticable on a large scale, mechanical and therefore electrical or compressed-air haulage apparatus is necessitated. Again, all underground work must be conducted by artificial light, and therefore (for the same avoidance of fumes) electric light; consequently electric wires and pipe lines have to be maintained under the worst possible conditions of moisture, corrosion by lime from "grout," and liability to breakage by blasting.

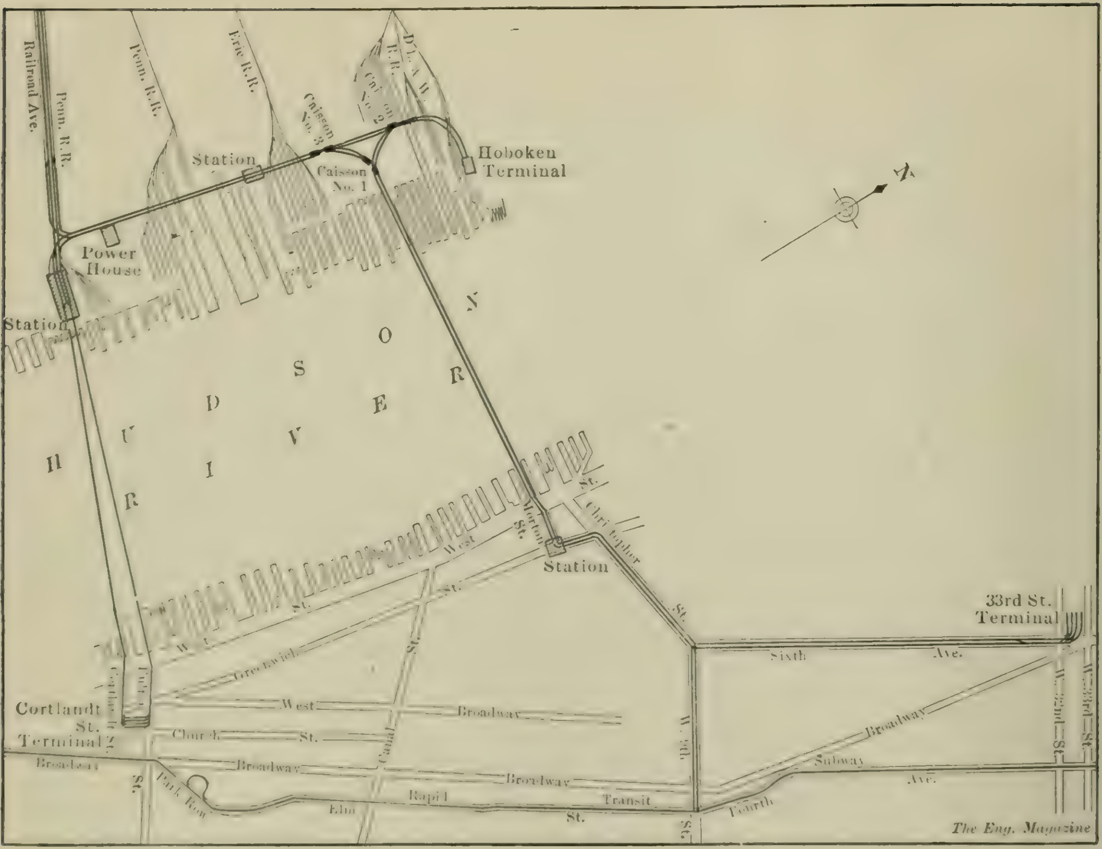
PART OF THE GREAT EXCAVATION FOR THE PENNSYLVANIA TERMINAL IN NEW YORK CITY.

It is approximately 400 by 1,600 feet in area, extending to the buildings seen in the far background and involving the removal of 2,000,000 cu. yds. of rock.

The unit costs of the various kinds of excavation at Panama have been carefully estimated and published by the Canal Commission, whereas unit costs are practically unobtainable from tunnel contractors, even where they are working on cost plus a fixed sum or cost plus commission basis, for the reason that the costs are governed so much by variable conditions as to vary not only between one tunnel and another but between different parts of the same tunnel.

As to labour conditions, there is no very great difference between the classes of labour employable at Panama and at New York, the principal consideration in both cases being the health of the employee; but whereas in the moist and malarial climate of the Isthmus the health of the population is fairly governable by proper medical and sanitary precautions, the tunnel companies have to contend with caisson disease, which after years of investigation is still almost an unknown quantity. It has been said that the men killed and wounded in tunnel operations are more in proportion to the number employed than the casualties of the Civil War, but this is probably an exaggeration; at all events, by the use of the medical lock for recompression of patients and the precaution of thorough pre-examination of compressed-air workers, most of the tunnel companies have so far reduced the number of cases of "bends" that the latter are exceeded by the number of accidents requiring surgical treatment, such as are bound to occur on any large contracting work.

To take in their chronological order the tunnels now completed or in course of construction, that which is now known as the "McAdoo tunnel" was the first transportation tunnel to be commenced, by some 30 years, and the first under the Hudson by several months to be completed. As originally projected in 1874 it was to have consisted of one large circular brick-lined tunnel, driven from a shaft at the foot of Fifteenth Street, Jersey City, to one at Morton Street, New York; this was abandoned. The present proprietors, the N. Y. & N. J. R. R., took up the work in 1902 and successfully drove the northern tube into the New York workings in March, 1905, completing its twin southern tube early in 1906, both under the direction of Mr. C. M. Jacobs, who had previously done successful pioneer work on the East River gas tunnel. To him, more than to any other one man, the success and the scope of present New York tunnel operations may be said to be due. Mr. Jacobs completed, where others for various reasons had failed, the first transportation tunnel under the Hudson, and is chief engineer of its extensive connections; he is in direct charge of a large part of the bigger Pennsylvania tunnels and on the consultative board to the whole system, and his work on

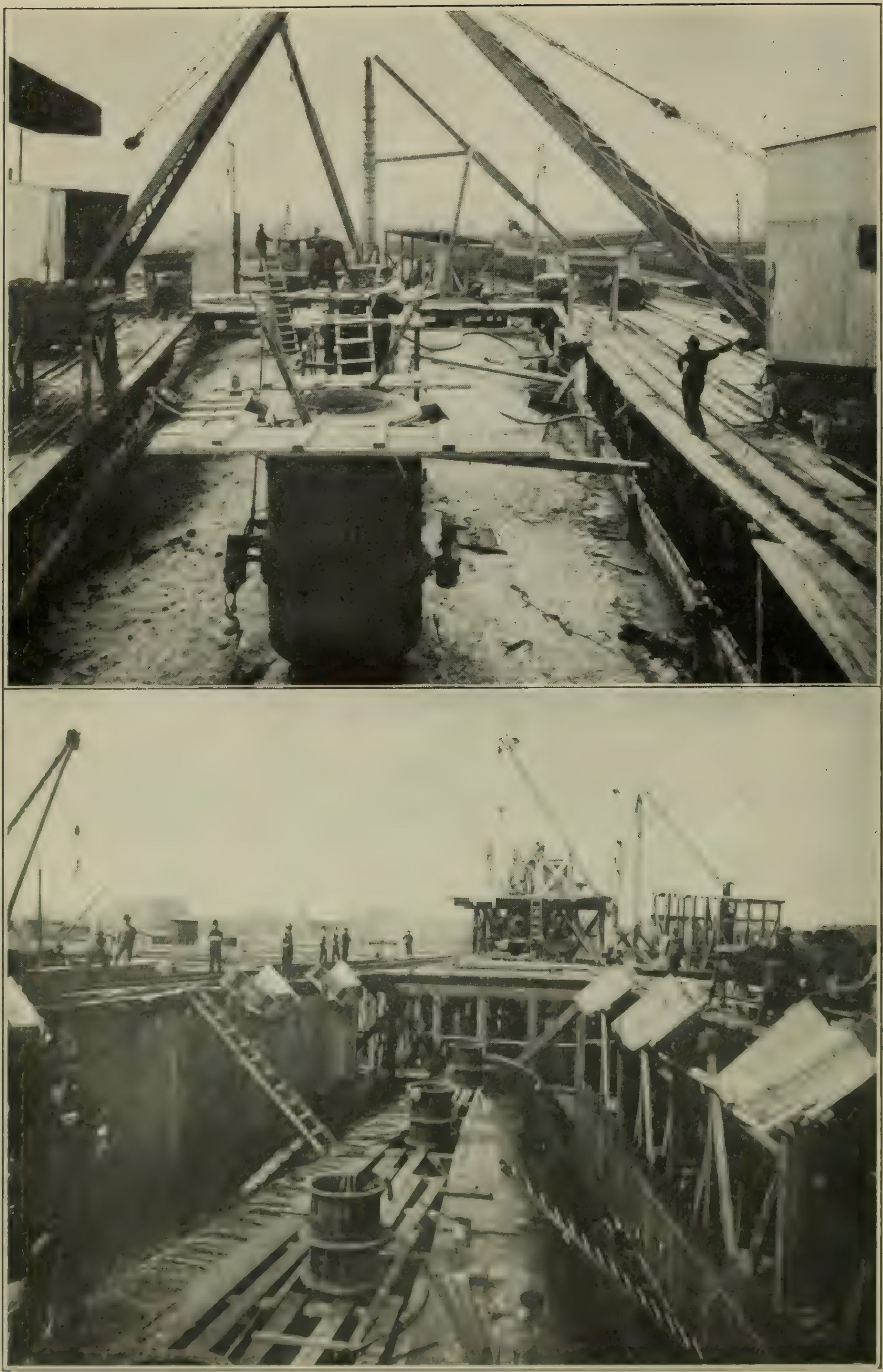


SKETCH MAP OF TUNNEL SYSTEM, THE HUDSON COMPANIES.
The map omits the northern part of the Railroad Avenue extension, north from the Penna. Station.

the East River gas tunnel has materially assisted both the survey and the forecasting of the ground to be encountered in the present East River railway tunnels.

The scope of the system including the original Hudson tunnel has been considerably enlarged by the alliance of the New York & New Jersey and the Hudson and Manhattan Railroads, and is now developed into an elaborate system best understood by reference to the accompanying map. The first two tunnels as completed are twin tubes 18 feet in external diameter and 5,650 feet long from shaft to shaft, and compose the northerly group shown on the diagram. From the New York end of these tubes, two tunnels are being driven through the city northward and eastward, via Brunswick and Christopher Streets to Sixth Avenue; there they fork, one branch turning east through Ninth Street to a junction with the Subway system at Astor Place, and the other running north under Sixth Avenue to a station adjoining the new Pennsylvania terminal at Thirty-third Street. This portion of the work, about two miles long, is not strictly tunnelling, being on the "cut and cover" principle. Meantime another pair of tubes, 16½ feet diameter and 5,070 feet long from shaft to shaft, are being driven under the Hudson about a mile south of the first system. They are slightly divergent at the New York end, making a loop with a four-track station in the enormous Terminal buildings now being erected at Church and Cortlandt streets. Converging as they go westward under the river, these tunnels enter the Jersey City station, under the old Pennsylvania terminal there. From this point reach two main arms of the system. One goes west, following the lines of the Pennsylvania Railway and directly beneath them for 5,500 feet underground, emerging then upon an embankment level with the Pennsylvania tracks and continuing thus for about 4,000 feet more to a junction with these railway lines at Summit Avenue. The other arm, connected with this last described by a Y, turns north, parallel with the river front, passing beneath the Erie and Lackawanna terminals about 10,000 feet into its own "Hoboken Terminal." Directly beneath the Lackawanna yards this arm connects by a Y with the two original river-tunnel tubes first described; the crossings of east-bound and west-bound traffic imposed by this arrangement at the Y under the Lackawanna yards and that just west of the Pennsylvania station are effected in every case by carrying one tube over the other. The design of this work and the caisson arrangement and

CURVE AT MORTON AND GREENWICH STREETS, HUDSON COMPANIES' "WESTBOUND" TUNNEL.



TWO STAGES OF CAISSON CONSTRUCTION, IN THE HUDSON COMPANIES' WORK.

From these caissons (underground excavated chambers, watertight and under compressed air) the tunnel shields are driven. The lower view shows caisson No. 2 partly completed, with timber form and steel re-enforcement for the concrete roof. The upper shows caisson No. 1 completed, with the air locks in place.

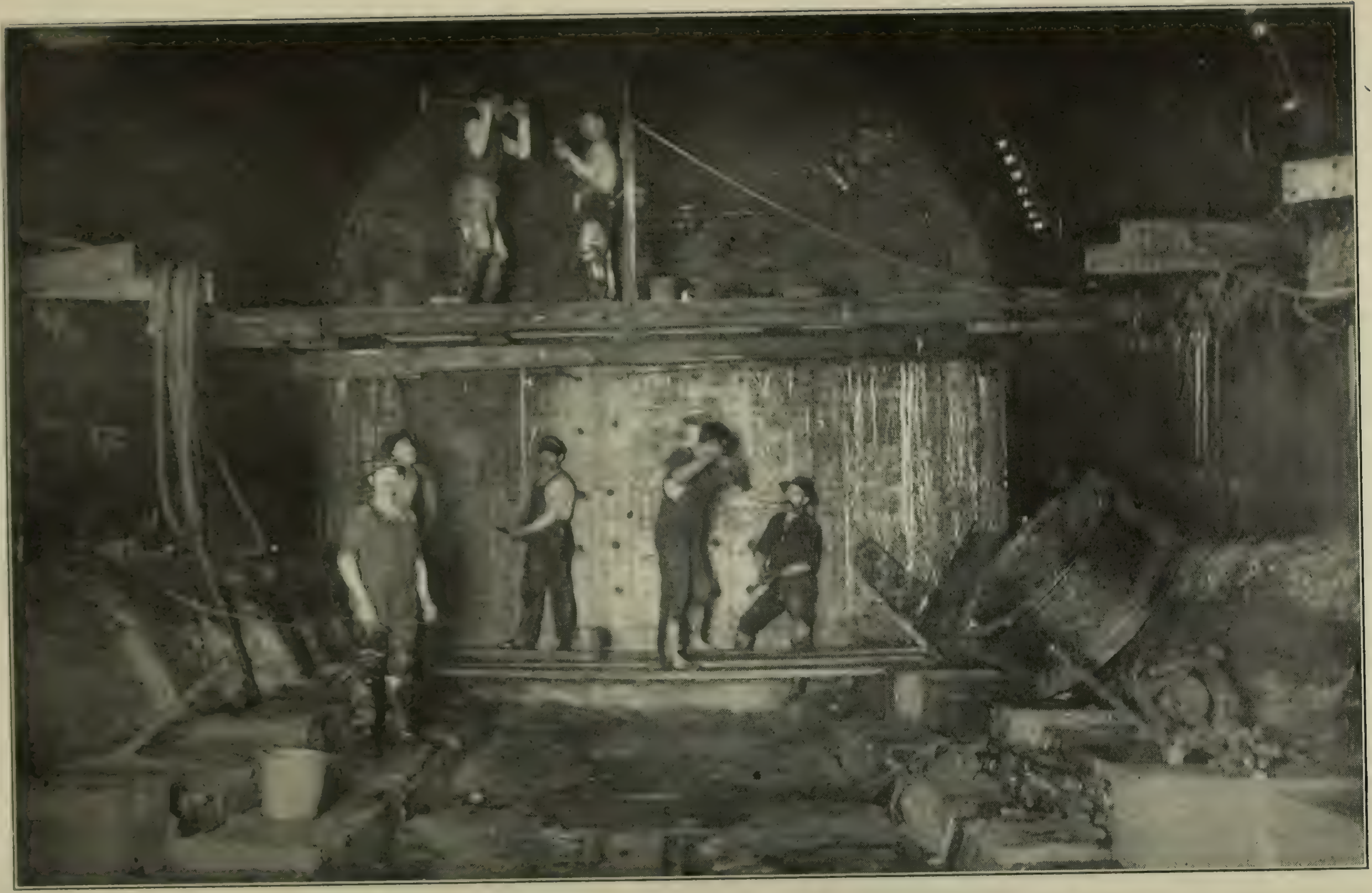
construction by which it was achieved are among the most interesting and admirable features of the undertaking. The power house of the system is situated upon this section last described, between the Erie and Pennsylvania stations. The whole work is designed, of course, to provide liberal and elastic communication between the urban and suburban transit lines of New York and those of the New Jersey side.

It will then be seen that by the aid of the system above described, the Pennsylvania Railway, in addition to its own immense tunnel system, will have facilities for distributing its passengers without their leaving the cars, at points corresponding to its present three New York ferry terminals, and even more widely separated than they.

The cars of the McAdoo system also, joining the Pennsylvania tracks as above described at Summit Avenue, Jersey City, will have running powers over the Pennsylvania system as far as the latter is electrified, and *vice versa.* Pennsylvania passengers will therefore be able to proceed not only by through expresses from Washington and the South via the new line from Newark under Bergen Hill and the Hudson to Thirty-third Street, New York, and through to Long Island, but also by local trains may pass through the down-town tunnels to Church Street and through the "mid-town" tunnels to Morton Street, Christopher Street, Sixth Avenue and Astor Place.

The second New York sub-aqueous transportation tunnel to be commenced, and the first by two years to be completed, was that under the Harlem River which is now in full operation—the only one of which the inside is as yet familiar to the travelling public. Whereas the width of the waterway traversed is less than one-tenth that of the Hudson and the difficulties encountered less in proportion, this tunnel is remarkable for the originality of the methods adopted and the complete success of the work, and deserves more extensive description but does not come within the scope of an article on progressing work.

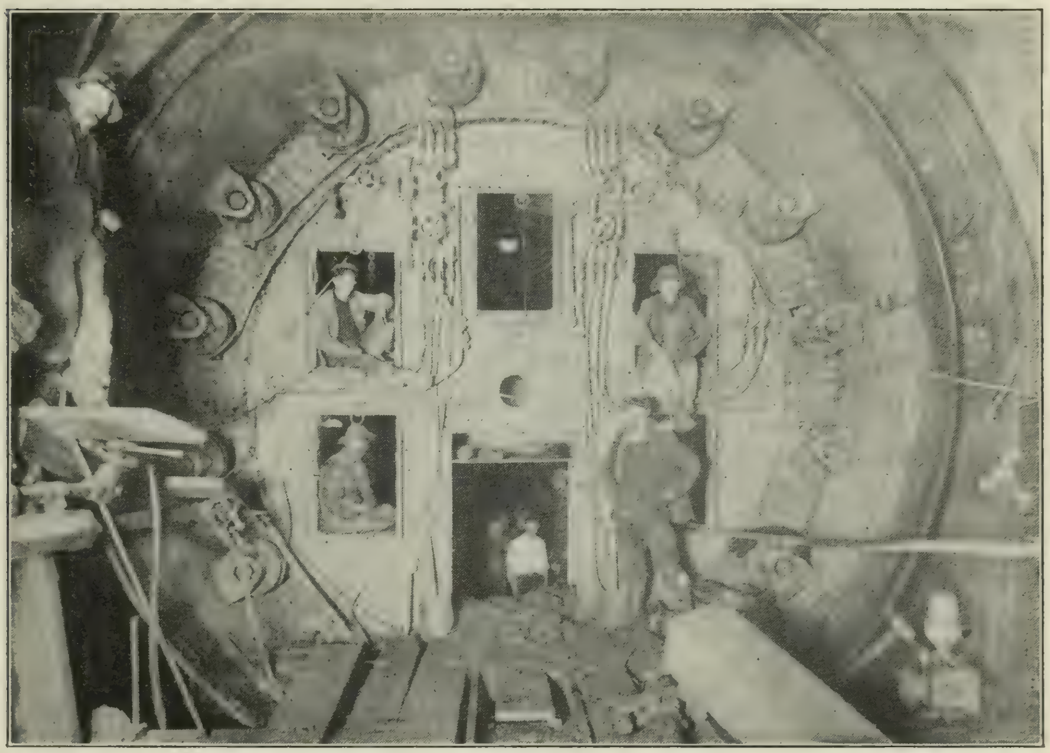
The third system to be commenced and the fourth to be completed is the Battery tunnel by which the Rapid Transit Subway is extended to Brooklyn. This system comprises two tubes each about 6,500 feet long, of which 4,150 feet is under open water, with 500 feet of approach tunnel from the present subway line at the Battery and an open-cut approach leading to the surface at the Brooklyn end. Work was commenced at the New York shaft in March, 1903, and at a corresponding shaft in Brooklyn, from which points each tube was driven from both ends; the two opposite headings of the northern tube met on December 14 last and an opening has just been made (March 1) between those of the southern tube. After the actual driving of the tunnels was commenced the average daily advance for



THE INTERIOR OF A CAISSON. CUTTING OUT THE CONCRETE "PLUG" THROUGH WHICH THE SHIELD IS TO PASS.

This is the Hudson Companies' caisson No. 1. At the bottom on both sides are seen the concrete steps for the ways on which the shield slides.

all four headings, including all delays, was 10 feet; the best daily record was 14 feet with the shield in coarse sand. These tunnels involve a total excavation of about 120,000 cubic yards of material of which only about 55 per cent is sand and other soft ground, the two tunnels being clear of rock for only 3,500 feet of their total length. The completed cost of the tunnel will be approximately $4,000,000, and of the entire extension about twice that sum. The tunnels will provide through connection between the whole of the present New York Rapid Transit Subway system, including its authorised extensions, and the system of the Brooklyn Rapid Transit Railways, and of several plans now projected it should be the most potent factor in relieving the present congestion of traffic on the bridges.

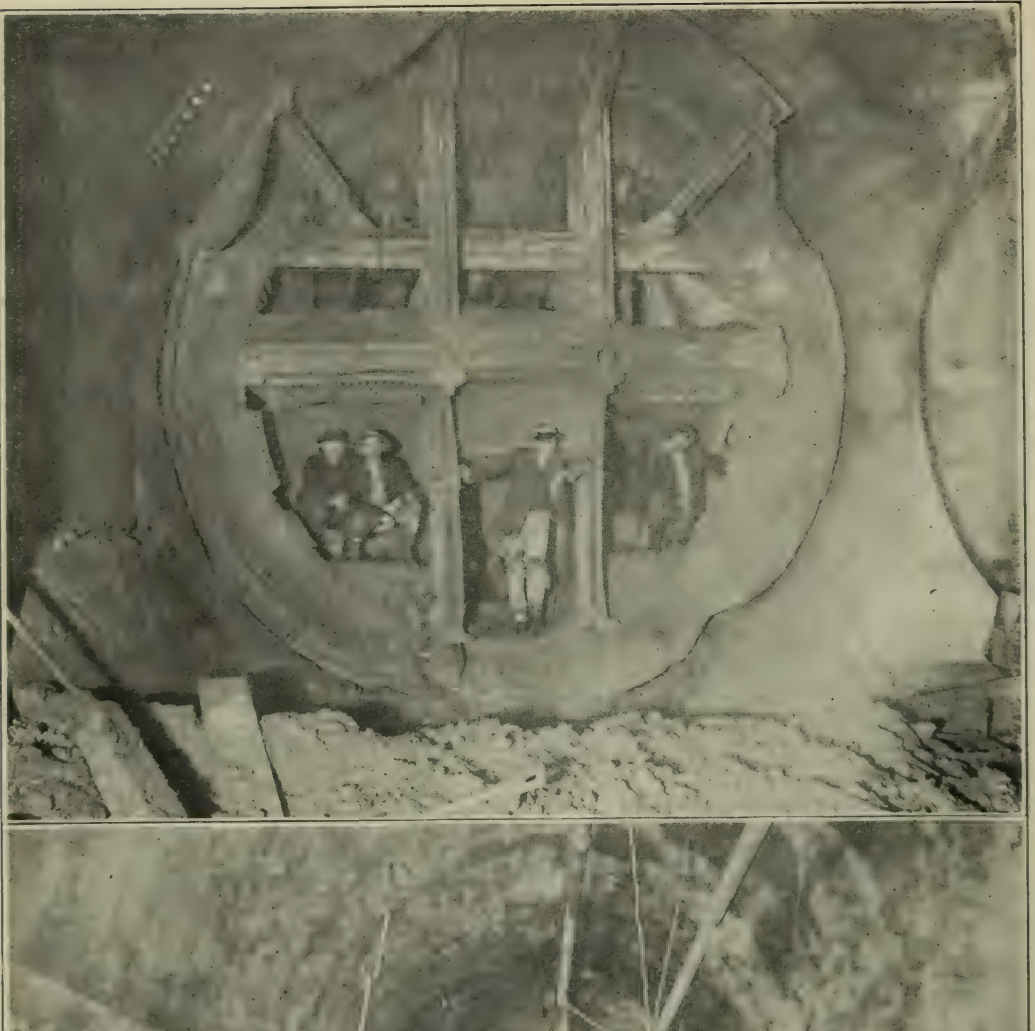


REAR VIEW OF A SHIELD, SHOWING THE "TAIL" IN WHICH THE IRON TUNNEL LINING IS ERECTED.

Around the edge are the jacks by which the shield is shoved, with hydraulic pipes supplying them. The spoil is thrown back through the small doors.

The fourth pair of tunnels to be commenced and the third to establish connections under water were the Hudson tunnels of the Pennsylvania system, and for greater convenience in making clear the advantage of this system in increasing transportation facilities it may be as well to describe the different portions of the work *seriatim* from the present Pennsylvania system instead of in the order of their completion.

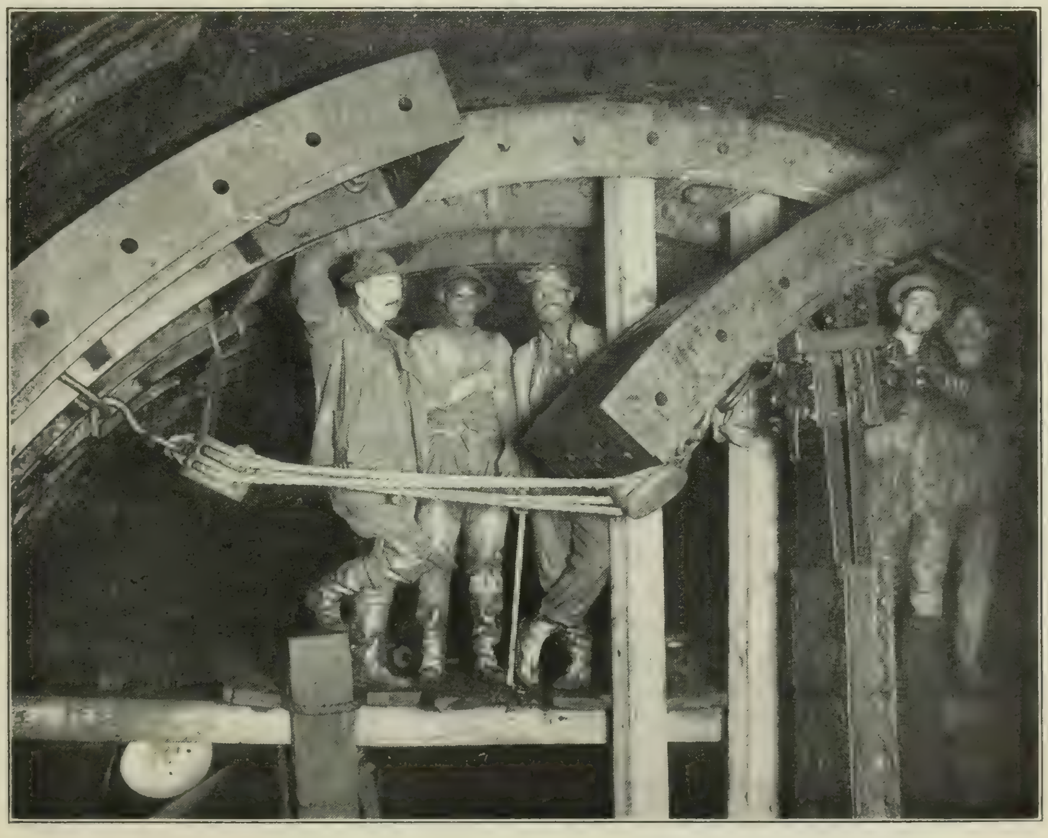
Two tracks will branch from the present line at Newark through Harrison, where a large yard, with round house, passenger station,



TWO VIEWS OF THE FRONT OF A SHIELD AS IT ADVANCES.

No. 3 shield of the Hudson Companies. Above, it is shown entering caisson No. 2; the cutting edge is damaged in service by blasting or by the powerful shoving of the jacks against obstructions. Below, it is moving through the old brickwork of the original tunnel entrance.

and 1,200-foot platforms, will be located. At this point electric locomotives taking power from a third-rail system will be substituted for the steam locomotives. From Harrison the new line follows the old Pennsylvania tracks for a mile, when it diverges to make a bee-line for the western portal of the Hudson tunnels where they enter Bergen Hill at Homestead, New Jersey. The tracks are carried on an embankment averaging 18 feet in height above the Hackensack "meadows," requiring 4,000,000 cubic yards of filling, most of which comes from the New York tunnels. The site of the Harrison yards has already been raised considerably and several acres of made ground completed along the Passaic shore; the dump for rock excavated from the tunnel under Bergen Hill also constitutes what will be the railroad embankment westward from that point.



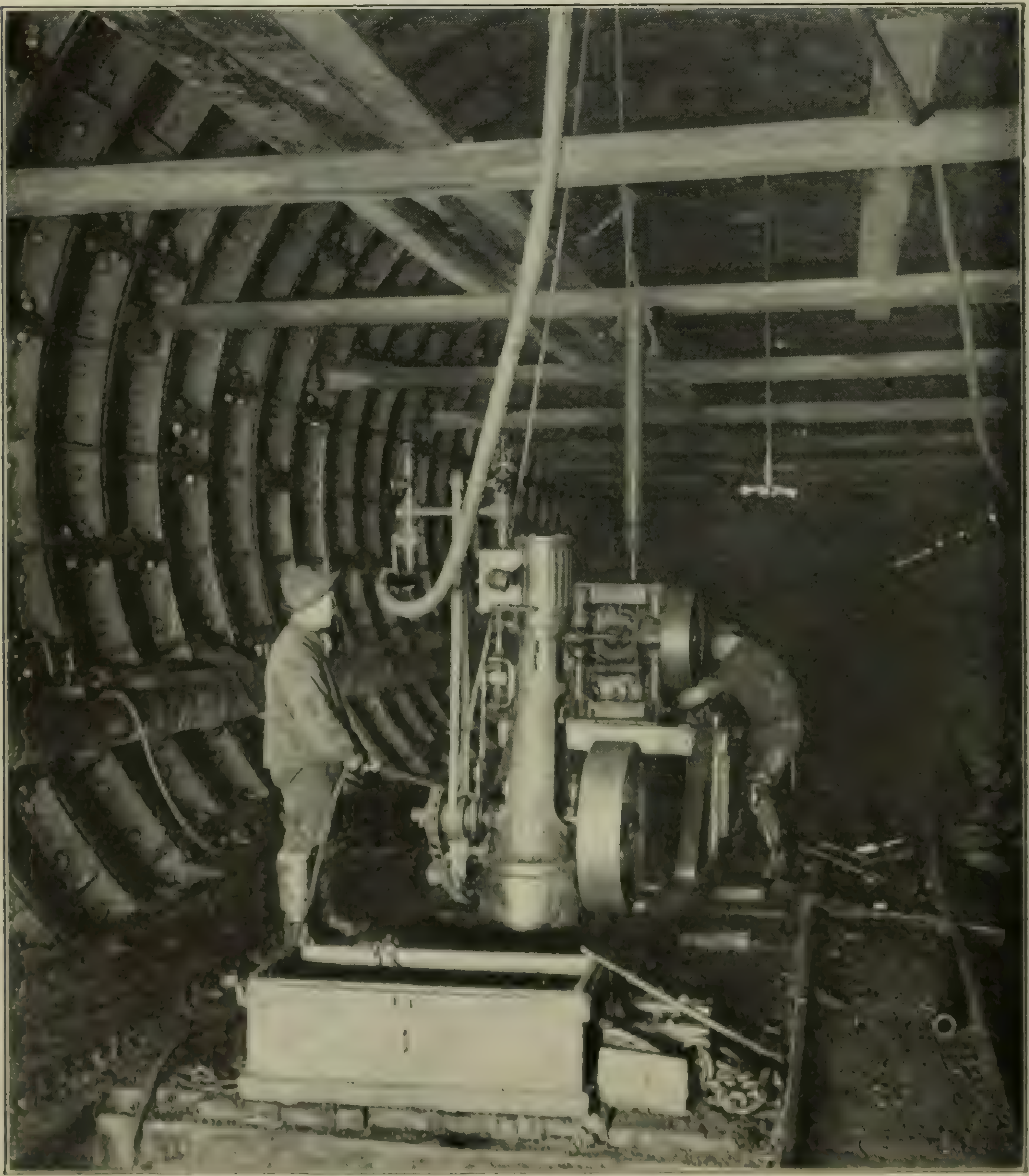
ERECTING THE IRON RINGS LINING THE PENNSYLVANIA TUNNEL.
The erector from the shield is mounted on timbers.

Large bridges are required where the new track crosses the Hackensack River and the present Pennsylvania and D., L. & W. tracks, the former being a drawbridge and the latter a series of spans aggregating 1,200 feet and somewhat complicated by the angle at which the tracks cross. The drawbridge will have masonry piers and abutments and the others concrete, the largest of the latter being 600 feet long, 20 feet wide, and 38 feet high, of which 20 feet is underground;

this work is now well advanced. These substructures are being built without any interruption of the traffic on either line which averages 20 trains an hour.

The Bergen Hill tunnels, of which there are two, each containing one track, will be 6,000 feet long from the Homestead portal to the Weehawken shaft. They are of horseshoe section, about 20 feet high and wide. Work on these is rapidly progressing, over 1,000 men being employed.

The Hudson River tunnels, of which there are two, each to carry one track, are 6,590 feet long from the Weehawken shaft to that at Thirty-third Street and Twelfth Avenue, New York, 4,430 feet being



INSIDE ONE OF THE PENNSYLVANIA TUNNELS.

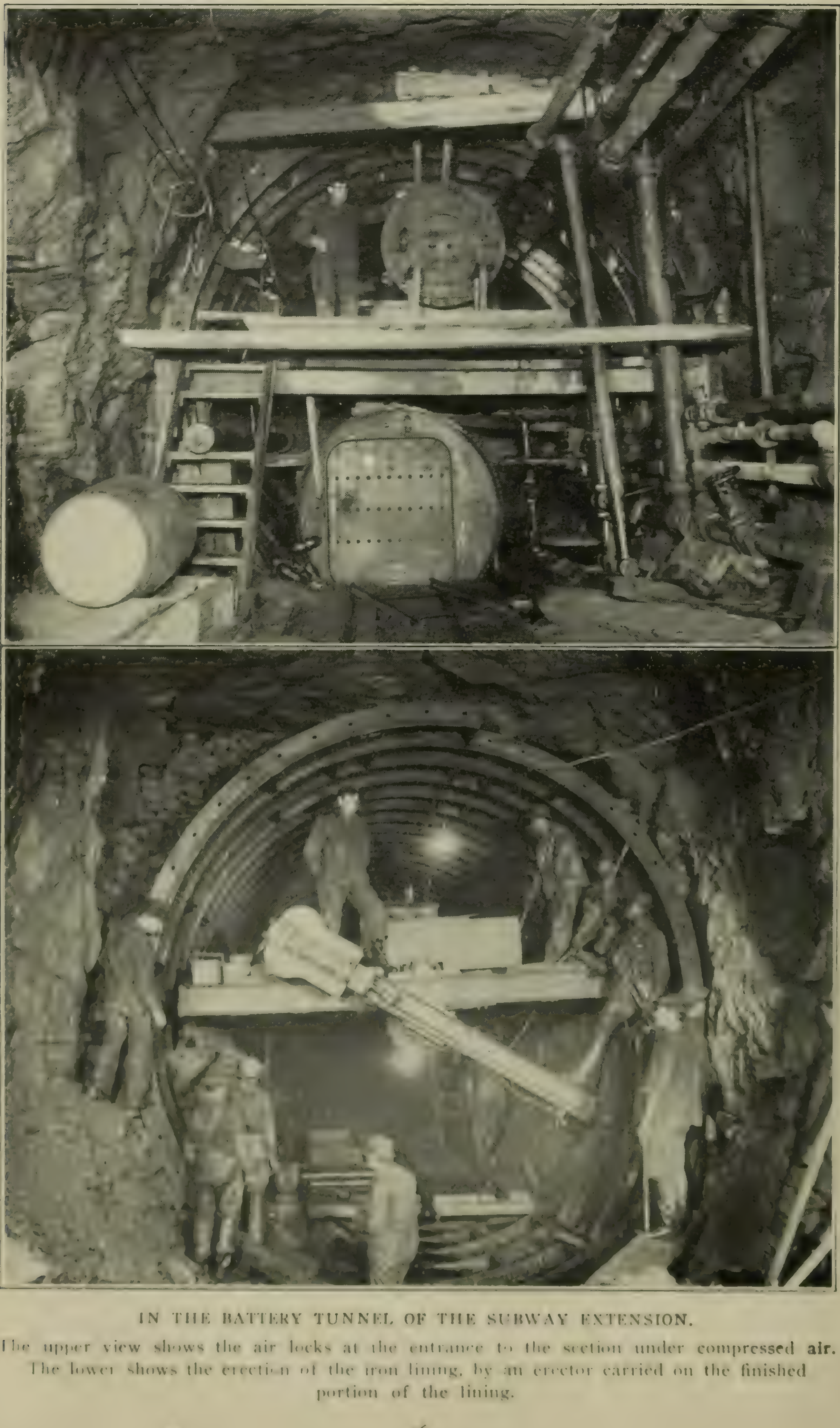
Making exploratory boring with the "Calyx" machine, for the screw-piles which are to aid in supporting the tubes.

under open water. These are 23 feet in diameter, lined with cast-iron segments, which will in turn be lined with concrete of a maximum thickness of 30 inches. Work on the shafts was commenced in June, 1903, and a heading started on the line of the tunnels in rock in October, 1904, from the New York end, and in the following January from Weehawken. When the shields emerged into the river silt very rapid advance was made, the two shields meeting under the river on September 12, 1906, in the northern tunnel, and not quite a month later in the southern. On account of the extreme fluidity of the material through which a large part of the tunnel passes, it is thought that when the removal of the air pressure decreases the buoyancy of the tube the added weight of the concrete and the live load of passing trains may cause it to settle, and as a precautionary measure against this steel screw-piles 2½ feet in diameter are to be sunk to bed-rock at intervals of 15 feet to support the iron. Some of these will have to be sunk to a depth more than 150 feet below the tunnel. The O'Rourke Engineering Construction Co. are the contractors for this portion of the work.

The next section from the Twelfth Avenue shaft to the Thirty-third Street station comprises two single-track tunnels almost entirely in solid rock for a distance of 2,700 feet. The terminal station site extends from Ninth Avenue to Seventh Avenue and from Thirty-first to Thirty-third Street, covering approximately 1,600 by 400 feet, and involves 2,000,000 cubic yards of excavation of which between 80 per cent and 90 per cent is complete.

The next 100 feet east from Seventh Avenue is being done by Messrs. Westinghouse, Church, Kerr & Co. to facilitate their arrangement of the electrical plant for which they are also the contractors; the remaining 5,500 feet of the cross-town tunnels is in the hands of the New York Engineering & Contracting Co. The latter part (eastward from the station) consists of two larger tunnels approximately rectangular in section as excavated, each to accommodate two tracks and to be lined with concrete so as to form two tubes symmetrical with those under the river, with which they connect in shafts at First Avenue. From thence, four parallel tubes will extend to a shaft at Front Street, Long Island City. These are also being driven by shields advancing from both ends, about 1,000 feet of the three southernmost tubes being constructed from the Manhattan end and nearly 300 of the northern, the Long Island headings to meet them having advanced some 300 feet.

This East River work on this system is being done by Messrs. S. Pearson & Son, Inc., who are also contractors for the next section,



IN THE BATTERY TUNNEL OF THE SUBWAY EXTENSION.

The upper view shows the air locks at the entrance to the section under compressed air. The lower shows the erection of the iron lining, by an erector carried on the finished portion of the lining.

from Front Street, Long Island, 2,000 feet east to East Avenue, comprising four tunnels joining those under the river; part of this work is in solid rock and part in mixed ground, some of the latter requiring heavy and elaborate crown-bar timbering, part having been done under air pressure and part atmospheric.

For the next ¼ mile eastward the contract has not yet been let; it is in ordinary Long Island soil with rock bottom, and will probably be excavated on the "cut and cover" principle.

Work on the Sunny Side yards at the Long Island end of the tunnel system is in progress and will require some 2,300,000 cubic yards of excavation, mostly gravel and sand, and some 2,000,000 yards of filling.

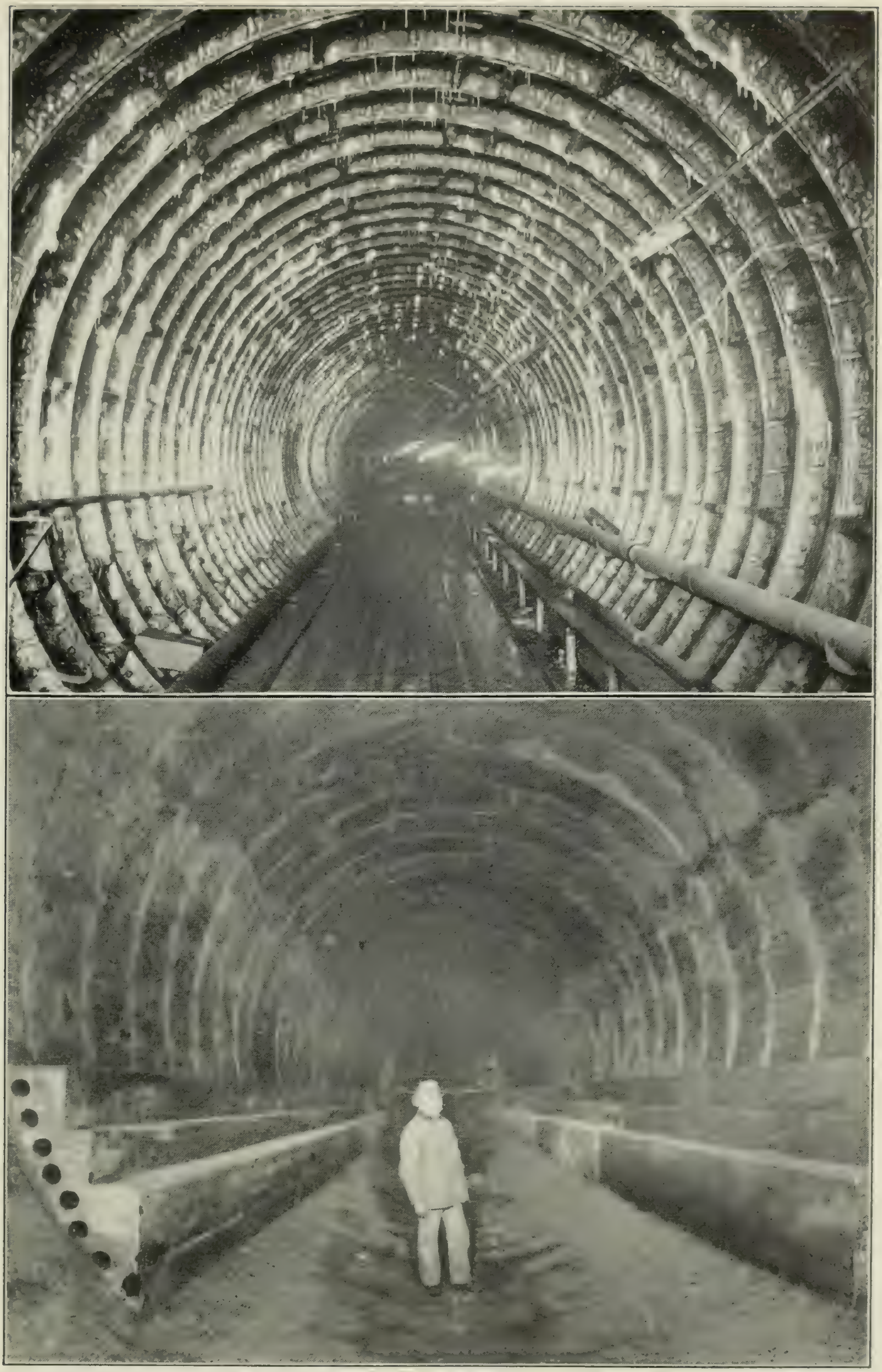
The advantages of this system, by which passengers from, say, Philadelphia can reach Brooklyn or any point on Long Island without two changes from train to ferry, or *vice versa*, and a drive across New York as at present, are readily appreciable. It is proposed to run trains from Thirty-third Street, New York, to Harrison, New Jersey, at an average schedule rate of 60 miles an hour. As there are no grade crossings and few curves or signal points in that distance it ought to be readily achievable. The advantages to suburban residents on Long Island will be no less, and when the Pennsylvania's dream of a great deep-water harbor for Atlantic liners at the extreme end of Long Island is realized, European mails, passengers, and freight will reach New York 4 or 5 hours earlier than at present, avoiding all delays of fog and traffic in the Narrows.

The New York & Long Island Railway is the next system to afford through communication, more especially between the surface-car lines of New York and Brooklyn. This system is composed of two tubes each 4,300 feet long under the East River at Forty-second Street, with approaches leading from the present Grand Central Station and out to the surface at Long Island City, the latter involving some 1,500 feet of open cut. Advantage was taken of Man of War reef in the middle of the river just below Blackwell's Island to accelerate the driving of these tunnels. A caisson was sunk within a cofferdam down upon and into the reef, from a shaft below which headings were advanced to meet those coming from the New York and Long Island shores, the excavation being thus attacked in four places instead of two. An extensive power plant and offices are now erected on an artificial island where formerly only a few feet of rocks was visible at low tide. Nearly three-quarters of these tunnels is constructed in rock, the remainder being mixed ground similar to that encountered in the P. R. R. East River tunnels.

Another undertaking of the first magnitude which is under full headway toward completion within and adjoining New York is the electrification of the New York Central Railroad and the new terminal construction connected with it. Briefly, this involves the excavation of a two-level terminal to accommodate 25 miles of tracks, the express level being 15 feet below the street and the suburban 25 feet lower yet, the present grade of the tracks being regained in about three-quarters of a mile. The total yardage to be removed for this work alone is estimated at 3,000,000 cubic yards, almost all rock. Electric operation will extend for 24 miles on the Harlem and 34 miles on the Hudson division, about 16 miles altogether (roughly) being now electrified. The two power houses, at Yonkers and Port Morris, will supply 40,000 kilowatts at 1,100 volts. The work was commenced in August, 1903, and will be completed in 1910. It must, of course, be carried out without suspending the operation of the enormous traffic of these roads.

Just crossing the threshold between preparation and construction by contract are the new Subway extensions known popularly as the "East Side" and "West Side." The former will run from the Battery to One Hundred and Sixty-fourth Street, by way of Church, Vesey, Broadway, Fifth Avenue, Thirty-fifth and Thirty-sixth, Lexington, and Park Avenues, with tunnel crossing under the Harlem River. It will have a total length of 12 1/5 miles of four-track subway, two-deck on Lexington Avenue and two-compartment elsewhere. The excavation will be all in rock above Fourteenth Street, and with the pipe galleries included may be expected to cost nearly $40,000,000. The "West Side" line runs from the Battery to a terminal near Woodlawn Cemetery, by way of Greenwich, Morris, West Broadway, Washington Square, Greenwich Avenue, Seventh Avenue to Fortieth Street, Central Park West and Eighth Avenue, McComb's Lane, One Hundred and Sixty-second Street, and Jerome Avenue. Like the other, it tunnels beneath the Harlem River. The total length will be 14 miles of four-track subway, with about five miles more of two-track subway extension on Jerome Avenue, and the expense of the work may be expected to reach $42,000,000 with a possible addition of $8,000,000 for pipe galleries. The "Bridge Loop," involving 7,000 feet of four-track subway in Manhattan alone, involves $5,000,000 for the work now advertised and $15,000,000 when the Brooklyn portion is included.

Into any conspectus of large engineering work in progress in Manhattan must enter also the East River bridges and some smaller structures over the Harlem and in the boroughs of Queens and the



THE BATTERY TUNNEL OF THE SUBWAY EXTENSION.

With the iron lining ready for the concrete, and with the concreting finished, ready for track laying.

Bronx. The Williamsburg Bridge, nearly complete, is to be altered on the Manhattan end to allow subway trains to run over the structure into Brooklyn. The cost of the original structure was about $12,000,000. The Blackwell's Island bridge, costing $15,000,000, is well advanced, the masonry being finished; and of the $20,000,000 Manhattan bridge the tower foundations are complete. The Pelham Bay, University Heights, and Borden Avenue bridges add another million to the total.

And beyond all this is the huge work for new water-supply, with present annual expenditures of $3,000,000 on contracts for possibly $40,000,000, and a total outlay of $162,000,000 in view. A *résumé* of the entire programme is given below:—

Work.	Principal Contractors.	Cost or Estimate.
Pennsylvania Tunnels and Terminals.	Wm. Bradley. O'Rourke Eng. Constr. Co. N. Y. Eng'g & Contracting Co. S. Pearsons & Sons. Westinghouse, Church, Kerr.	$100,000,000
Hudson Company's Tunnels, Subways and Terminal.	Hudson Co. Degnon Contracting Co. O'Rourke Eng. Constr. Co.	100,000,000
New York Central Terminals and Electrification.	O'Rourke Eng. Constr. Co. General Electric Co. General Railway Signal Co.	80,000,000
Battery Tunnels and Subway Extension.	Degnon Contracting Co. N. Y. Tunnel Co. Cranford & McNamee.	9,000,000
N. Y. & L. I. Tunnels.	Degnon Contracting Co.	4,000,000
Subway Extension and Pipe Galleries. East Side.	Not yet let.	40,000,000
Subway Extension and Pipe Galleries. West Side.	Not yet let.	50,000,000
Subway Bridge Loop.	Not yet let.	15,000,000
Manhattan Bridge.	Ryan-Parker Construction Co.	20,000,000
Williamsburg Bridge.	N. J. Steel & Iron Co.	15,000,000
Blackwell's Island Bridge.	Penna. Steel Co.	15,000,000
Smaller Bridges.	Snare & Triest, Lawler Bros., Degnon Contracting Co., Godwin Construction Co.	1,000,000
	Total	$449,000,000
New Water Supply.		162,000,000
	Grand Total	$611,000,000
	Estimated Cost of Panama Canal	$190,000,000

The fact that all this extensive and important work is going on untainted by any breath of scandal in direction or execution, unheralded by any Presidential messages to Congress, little discussed by even the local press and almost unadvertised by its promoters, is striking by comparison with the amount of attention given to the National construction of an Isthmian Canal. The quiet and efficient completion of all these great improvements by public contract is an interesting commentary on the controversy aroused by the action of the Government with reference to Panama contractors.

TEMAGAMI STATION. A DAILY SIGHT IN SUMMER.

COBALT, CANADA, THE NEW SILVER-MINING DISTRICT.

By J. E. Hardman.

The remarkable richness and complexity of its deposits, and the absolutely unique character of its geological structure have given to mining in the Cobalt district an unparalleled interest and uncertainty, an interest which in less than three years has gained for it a world-wide reputation, and an uncertainty which the accumulated experience of its history has not been able to remove. Mr. Hardman's article, based upon an extensive personal acquaintance with the district, presents a review of the conclusions which may be drawn from present conditions.—THE EDITORS.

THE preamble to the Act authorizing the construction of the Temiskaming & Northern Ontario Railway, among other paragraphs contained the following clause: "Whereas exploration of the Province (Ontario) has shown that, in that district of Ontario which lies between Lakes Nipissing and Abitibi and northwesterly from Lake Temiskaming, there are . . . . deposits of ores and minerals which are expected upon development to add greatly to the wealth of the Province . . . . ," the clause having been framed without any knowledge (on the part of the Legislature)

ON THE LINE OF THE T. & N. O. RAILWAY.

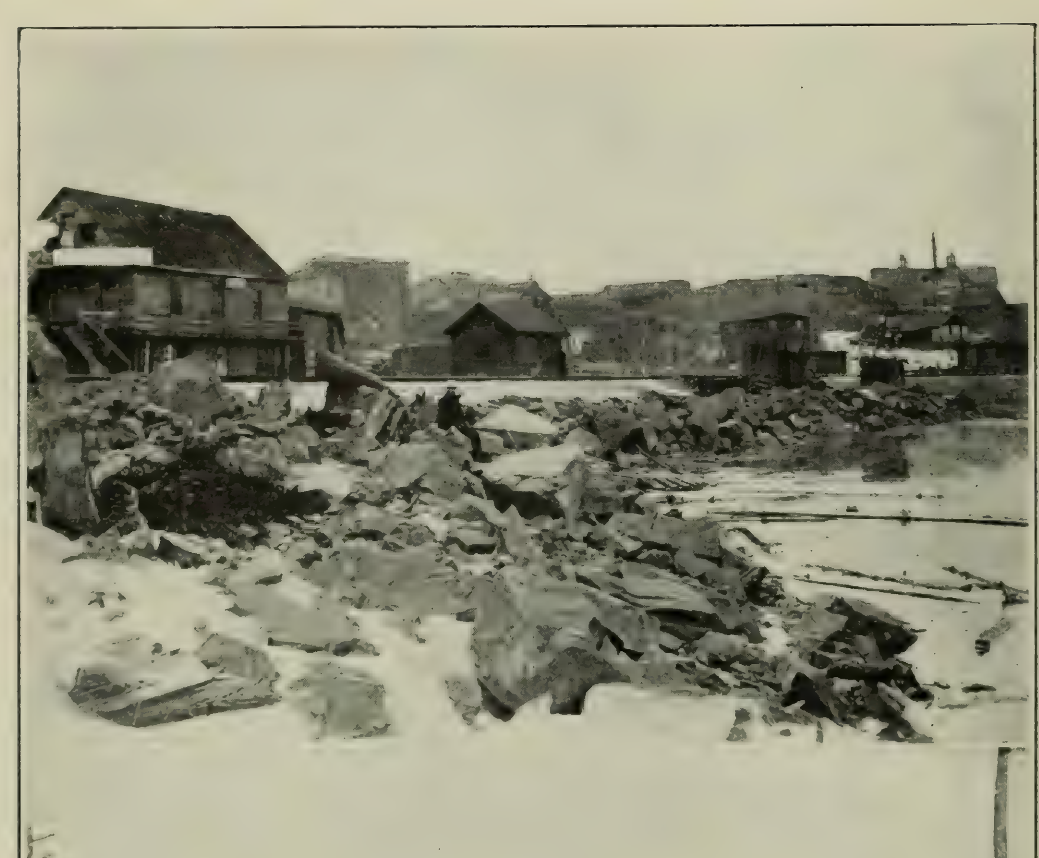
The upper picture shows the McKinley-Darragh mine, from the track.

of the significance of its language, or of the vast amount of mineral wealth which this railway would open up. Nor had the first discoverers of silver, Messrs. McKinley and Darragh, when in July, 1903, they stumbled on the outcrop of a rich vein on the southern shore of Long Lake (now known as Cobalt Lake) any conception of the value of their discovery, or of the tremendous influence which that discovery would exert upon the financial barons of Wall Street and other big money centres.

THE MCKINLEY-DARRAGH—THE ORIGINAL DISCOVERY OF COBALT CAMP.

The district is decidedly unique, and has earned the adjective "freak" which was bestowed upon it last summer by the eminent engineer, Mr. John Hays Hammond. It is a freak because it does not conform to the experience experts have had in other silver-bearing districts, and because its eccentricities are not yet understood, and by reason of its petrology, which is unique.

The district of Cobalt in its larger sense embraces portions of the townships of Coleman, Lorrain, Bucke and, in all probability, portions also of the townships of Firstbrook and Dymond. In its narrower sense it is confined to an area of six or seven square miles in the eastern half of the township of Coleman. It derives its name from the prevalence of the metal cobalt in the distinctive mineral of the region, which is smaltite, an arsenide of cobalt. By rail the town of



TWO VIEWS IN COBALT—BELOW, A TYPICAL STREET CROWD; ABOVE, THE NORTH END OF THE TOWN.

Cobalt lies 103 miles north-northwesterly from North Bay, a station on the main line of the Canadian Pacific Railway at the head of Lake Nipissing. Cobalt is 330 miles nearly due north of the city of Toronto, which is the chief supply centre for this new region.

Tales concerning the first discovery are somewhat numerous, but there are two well authenticated stories which, briefly, are as follows:— Messrs. McKinley and Darragh, both experienced lumbermen, having a contract for the supply of ties for the Temiskaming & Northern Ontario Railway, had frequent occasion to pass from the line of the right of way to their tie camps by way of the southern end of what is now called Cobalt Lake. On one of these occasions the outcrop of a vein which carried heavy mineral was noticed, and some of that mineral was taken in to the railway camp and was, at first, somewhat naturally taken for copper ore as it was niccolite, which carried the usual bright red bronze colour. The then chief engineer of the railway, Mr. W. B. Russell, later took a piece of the ore to Toronto for examination and analysis. Other pieces were also shown to Mr. Thomas W. Gibson, then Director of the Bureau of Mines, now Deputy Minister of Mines, who at once recognized its unusual character, and on his return to his office at the end of October 1903 instructed the Provincial Mineralogist, Mr. W. G. Miller, to visit the locality at once and make as thorough an examination as possible.

THE NOVA SCOTIA MINE.

Nearly contemporaneous with this discovery by McKinley and Darragh came the accidental discovery of metallic silver by a blacksmith named LaRose, who was in the employ of the contractor for the building of the railway. His story is that, being at his forge one day near the northern end of Cobalt Lake, he saw a red fox near by in the bush and threw his hammer at it; parenthetically without damage to the fox. On going to recover his hammer he noticed that it had bruised a rock, and that the bruise gave a bright metallic streak which the blacksmith supposed was due to lead in the rock. Subsequent investigation by some of the officials led to a sample being sent to Toronto where a remarkably high yield of silver was obtained.

VIEW SHOWING VEIN 49 AND OTHER WORKINGS ON THE NIPISSING, WITH THE SILVER QUEEN AND MCKINLEY-DARRAGH IN THE FOREGROUND.

At this time steel was not yet laid to Cobalt Lake, and little attention was paid to the matter or known about it until after Professor Miller's visit in November, 1903. Subsequent press reports and an extemporaneous address on the new ore field, illustrated with large samples of the ore, given by Mr. W. G. Miller at the annual meeting of the Canadian Mining Institute in Toronto, March, 1904, brought the matter to the attention of Canadians and made it evident to the public that a new, and possibly very valuable, ore field was extant in Eastern Canada.

In the meantime two experienced Canadian prospectors who were familiar with that region, the Timmins brothers from Mattawa, and

THE ORIGINAL VEIN, KERR LAKE MINING COMPANY.

two railway contractors, the McMartin brothers of Cornwall who had had experience in British Columbia, had become interested in the reports concerning the new finds and, by purchase, obtained from LaRose the rights to the 40 acres of land which he had taken up from the Government. These gentlemen at once began work upon this property which has since attained an enviable notoriety as a producer; the "Timmins" mine being considered (and justly so) one of the best mining properties of this new district.

About New Year, 1904, or a little later, five local men formed a syndicate known as the Chambers-Ferland Company, who located 846 acres in the heart of the old Cobalt district. In the fall of 1904 these gentlemen sold out their rights for $250,000, to what is now the notorious Nipissing Mining Co. and Nipissing Mines Co., whose shares last fall displayed such a meteoric rise and fall, but whose property has such immense possibilities for the future.

VEIN 49, NIPISSING MINE.

Early in May, 1904, locations J. B. 7 and J. B. 6 were made by Mr. W. G. Trethewey who at once began operations on J. B. 7; this is now the property of the Trethewey Silver Mining Co. and J. B. 6 has been incorporated into the Coniagas Mining Co. whose peculiar but distinctive name is made from the chemical symbols of cobalt, nickel, silver, and arsenic—Co, Ni, Ag, and As.

These four properties just enumerated were the only ones to make any shipments during the year 1904; as a matter of fact steel was not laid, so that traffic from the town of Cobalt could commence, before the last week of October, 1904, and all the shipments made were sent out after the first of November. Nevertheless during those two months 158 tons of ore containing 206,875 ounces of silver worth $111,887 were sold and shipped. After this time discovery followed discovery in rapid succession, and the outlying parts of the district, such as Cross Lake and Kerr Lake, yielded valuable discoveries, so that the production for the year 1905 amounted to 2,451,356 ounces from 2,144 tons; and the production for 1906 has been given as about $4,000,000, from 5,129 tons. The total production therefore of this new district is close to $6,000,000 for all the time it has been productive, which, as above noted, is practically but two years. Estimates of the production for 1907 are but mere guesses at this early date; nevertheless the greatly increased area over which profitable production may be expected make it certain that this year's yield will surely be double that of last year.

The increased area just spoken of comes from discoveries which have been made since July, 1906, at which time the productive area was limited to about five or six square miles. The discovery of the Bucknell and Mitchell claims on the south line of Casey township, that of the St. Denis near Martineau Bay, the Ontario Government's work, southerly, within the Gillies timber limit, and the discoveries on Portage Bay to the west have increased the area to more than 100 square miles, although it is now practically certain that such high values as have obtained in the older district will not prevail throughout the larger area; but this increased size of territory will lengthen the productive life of the field, because of the increased tonnage of low-grade ore which it ensures. At the present time low-grade ore, in the language of the camp, is anything less than 100 to 150 ounces of silver to the ton—a statement which will be surprising to many engineers in other localities to whom such a yield would be considered high-grade. In connection with this

THE CONIAGAS MINE SHAFT.

THE PETERSON LAKE DRAINAGE CHANNEL.

larger area it may be permitted to state that the resources in mineral of this northern country in the provinces of Ontario and Quebec are enormous and entirely unknown to the general public. Credible reports have been received of the discoveries of additional silver districts, of gold-copper deposits, and of free gold quartz, in this northern country; and it is known that the country south of this silver district contains several valuable bodies of iron ore, of copper ore, and perhaps of other varieties of silver ore.

The geology of the district has not yet been written in detail, nor can it be until greater development has been made. The earlier observers were justified, at the time, in making the statement that the ores occurred only in *one* series of the Huronian formation; but developments have shown that the values pass through all the series of the Huronian and, in some cases, through the Keewatin and diabase; witness the Green-Meehan and the University Mines.

Roughly speaking, the characteristic rocks of the region are the altered, ancient, plutonic rocks characterized as of the Lower Huronian period and consisting of conglomerates, agglomerates, breccias, and tuffs, with quartzites and slate in the lower portion: the greenstones and quartz-porphyries of the Keewatin age, and greenish to black diabase which is found not only as dykes and intruded masses in the agglomerates but also occurring as sills and overflows.

Much of the so-called conglomerate is more properly an agglomerate; it consists of angular, sub-angular, and occasional rounded fragments of grey and red granite in a mass of porphyrite or volcanic tuff. The fragments vary in size, the larger ones averaging on the exposed faces less than 3 by 4 inches, but the majority being under one square inch in area; the distribution of these fragments is very irregular and the angle of the beds is nearly horizontal.

This rock weathers to a greyish tint and in deep workings appears to become less, or non-fragmental. In some places the agglomerate passes into a fine-grained slaty rock which in turn grades into an impure quartzite. Through the conglomerates, and sometimes passing through and beyond the underlying diabase, or greenstone, occur calciferous veins carrying metallic silver and sulphides or arsenides of silver with smaltite and niccolite, the two latter minerals being the arsenides of cobalt and nickel. These veins apparently occur along the main lines of fracture by which the conglomerate has been shattered. The whole of the conglomerate has been split or fractured by a system of planes which cross each other approximately at right angles. These jointing planes near the veins often contain thin plates and filaments of native silver, and occasionally sparkle with minute crystals of the silver compounds mentioned above. It is along some of these jointing planes that lines of fissure follow, and are

THE SAVAGE MINE. SACKED ORE PILED AROUND THE HEAD FRAME ON THE RIGHT.

filled with calcite, smaltite, niccolite and the other characteristic minerals of the region, thus constituting the so called veins. The veins are not "true fissures" in the ancient and time-honored meaning of that word; they are rather openings occasioned by the cooling of the rock, or cracks occasioned by disturbances due to intrusion of the diabase.

THE SILVER QUEEN PROPERTY AND BOARDING HOUSE.

In places the cross-fracturing referred to has jointed the walls to such a degree that the mineralizing solution has penetrated to considerable distances from the vein, from 3 to 5 feet for example; in this way occur many of the thin plates or laminated sheets of metal, which, when mined in a large way, form the low-grade ore of the district, of which possibly a large tonnage will be made in the future. Some of the fissures or partings are found without this jointing in the walls, and in such cases very little or no second-class ore occurs. In other cases the larger fissures exhibit slicken-sided walls, and where the fractures are double, or run in pairs, (as is exhibited in the main vein of the Drummond property) they are frequently jointed by independent, and nearly horizontal, seams or veins which in the instance mentioned frequently carried the highest values. Some of the veins in their vertical extension are subject to faulting by planes approximately horizontal, and the throw varies from 2 feet to 10 feet in the instances which I have observed. Several of these so-called veins do not reach the present surface but are "blind" veins, and are only found by cross-cuts from underground workings.

The limits of this article will not permit of descriptions of the individual properties from which the production of silver has been made, but from the experience they have afforded, it may be justifiable to infer that the richer and larger depositions of the valuable minerals assume the form of very much elongated lenses, dipping at a slight angle from the horizontal in the plane of the vein. The depth (on the dip of the vein) to which the rich lenses, which crop to the surface, carry varies apparently, from 60 to 80 feet, at which depth the zone becomes impoverished for 20 to 60 feet, the vein producing only low-grade ore. This low-grade ore is then replaced by another pay chute coming in, which continues for another indefinite distance, probably 50 to 60 feet, when it is succeeded by another lean streak, and so on. The deep shaft of the La Rose Mine, as I am credibly informed, substantiates this idea, and it is further borne out by the testimony of Mr. M. T. Culbert, the manager of the O'Brien Mine, given in a recent suit at law. Unfortunately for a sound generalization, the two mines mentioned are the only ones which have attained depths sufficient to justify any attempt to draw conclusions; one of these two mines is strictly closed to engineers for inspection and examination, and the other reaches its vein by means of cross-cuts from a vertical shaft, so that inspection of the whole vein to the present depth of over three-hundred feet is not possible. It therefore should be distinctly understood that the inference above drawn is one deduced from quite restricted premises.

As to the permanency of these deposits entirely different opinions have been expressed, but as time and experience are obtained the trend of opinion is distinctly towards a long life for the district. Mr. H. W. Hardinge has made an argument for the continuation of values to depths, from the premise of the large area over which mineralization is now found; substantially he says that, if the mineral came from one main source, and by the time it reached the surface impregnated an area of five square miles, leaving values in at least three overlying formations, then the source must be very deep. From such a line of reasoning great depths may be expected, particularly as a vastly larger area than five square miles has been mineralized, as recent discoveries have shown. Time, and developments to the deep, are needed to give valuable information on this question.

That metallic silver diminishes with increased depth and that the sulphides tend to increase the depth has been observed in one or two mines, but it is also well-known that some of the surface veins which have yielded very high values have shown little or no metallic silver. At about 220 feet in the La Rose shaft the metallics are very much less in quantity, whereas argentite and pyrargyrite are much increased in quantity; at the Drummond Mine, at 130 feet from the surface, ore having no appearance of value yielded about 500 ounces of silver to the ton.

The fact that the lines of fracture are approximately vertical, that these lines as a rule coincide with the system of joint planes prevalent through the rock, and that the fracture lines continue below the surface agglomerate or conglomerate, are all facts in favor of persistence of the fractures or fissures in depth; whether values will be maintained in the continuous gangue matter is not so easy to predicate. But without question a camp or new district that has produced $6,000,000 in so short a time, which has energized Wall Street as did "Nipissing," and which contains ores which are richer (so far as quality is concerned) than those of any other known camp, is bound to have a noteworthy career, and to increase greatly our present knowledge of ore deposits in general, and of this class in particular.

HYDRO-ELECTRIC POWER VERSUS STEAM FOR INDUSTRIAL PLANTS.

By H. von Schon.

Mr. von Schon, in the article below, examines thoroughly into the comparative claims of fuel and of water power as initial sources of energy. In following issues he will show successively how the commercial and the engineering studies of a hydro-electric proposition should be made, summing up with a description of typical plants and a list of opportunities waiting development.—The Editors.

IN the strife of men for betterment in industrial developments their leading thoughts and aims center in two goals—" economies of methods and perfection of output "—and of the means to this end no single factor plays a more important part than power.

Shaped in the minds and by the hands of Watt, Sickles, Corliss, Greene, Porter, and thousands of their worthy followers, the steam engine has become a thing of perfection, annihilating time and distance and making the apparent impossible a matter of fact. But another Richard entered the arena when electric energy was brought under practical control; the autocracy of steam as the supreme power agent was challenged, fought, and for aught one can know today, may be doomed to defeat at the hands of this mighty rival.

And, now in our day we are approaching the third milestone in power history, the distant transmission of electric current, the perfection of which not only threatens to put steam as a power agent in the second place of importance, but reaches out boldly for the crown worn so long and undisputed by King Coal as the prime source of energy, and may force his late majesty to restore to old Neptune some of his former glory in moving the wheels of industry. And thus today the world's search for economy and perfection is not only as to the power applied to the work, but may be extended with good promise of reward to the further inquiry for the prime source of energy. To subject this query to a searching analysis is the intent of this series of articles, which are written for the purpose and with the hope of leading the men who project and exploit industrial enterprises to recognize its far-reaching importance as being one of the basic conditions which, in co-operation with others, must be correctly determined in order to insure the greatest practicable commercial success.

Steam vs. hydro-electric power or, more to the point, fuel vs. water-power energy, is the subject to be weighed, and primary and fundamental to its discussion steam vs. electric current must be arrayed, as water power and electric energy combined, and made one in their effective work, must fall or stand together in a claim of supremacy against steam power.

What are the important features of the power plant and its service which contribute to the successful operation of a shop or mill? They may be grouped under four heads:—availability, adaptability, efficiency, and cost.

The power must be constantly available; should it fail for any reason whatever the shop or mill ceases to operate.

The cause of failure of a steam plant may be want of fuel. The fuel resources of the world are very large but they are not generally distributed, and even their proximity is no guarantee of continuous supply, as other agencies must be reckoned with. Producing and transporting the fuel is one of the most important enterprises of this day; the organizations caring for it are complicated and not always reliable; strike and car shortage are of recent occurrence, and not only has the fuel supply at times in recent years been aggravatingly uncertain, but the reader will recall the fact that only last winter a large portion of the western United States was not only without fuel for shop and mill operation, but great hardship was caused because no coal was obtainable for the heating of houses. This was not caused by strikes, but because the great transportation lines, which the world justly holds up as models of organization and enterprise, these all powerful carriers for weeks and months could not command cars to carry coal to the suffering West.

What guarantee then lies in the million-ton deposit or the million tons mined, if means of bringing it to the point of consumption are uncertain?

A few years ago the mining of coal ceased in the United States for weeks and months because the operators and miners disagreed, not only on questions of wage, but on matters of management, in which the laborer of today claims and is granted a large voice. Are there any assurances that labor and transportation of the future will guarantee a more constant supply than in the past? At best this seems doubtful.

Power may not be available because the plant needs repairing, A steam plant consists of many parts, chief among them the boiler and the engine, and appurtenant to these are the feed pump, water softeners, water heaters, stokers, condensers, injectors, and other minor equipment. All these are refined machines subjected to severe strains and in parts rapidly wearing. Furnaces have to be relined frequently, grate bars renewed, pumps and engine repacked, and the boiler itself at best is but short-lived; often such repairs take hours and days, and unless the plant contains spare units, delays of continuous power service are a certainty under the best conditions.

Individual machines in shop or mill may be stopped for want of motive power on account of repairs required by the mechanical drive by which the power is distributed; line shafts, hangers, pulleys, belts, all need frequent attention and periodical renewal.

Subjecting hydro-electric power to a like examination as to availability we find that it requires no fuel; its energy source is falling water. That "the mill will never run with the water that has passed" is a perversion of the facts, since the endless chain, from clouds to river and ocean and by evaporation back to clouds, represents the law of Nature.

This supply is distributed over all sections; every stream represents such energy. It is probably true that water power in many minds is associated only with a water fall, but as a matter of fact the most sluggish stream represents, in the practicable accumulation of the fall required for its flow, water power. In Germany today water powers are being developed with falls as low as three feet.

The available supply of this energy is as unknown as that of fuel; it is everywhere, and its availability for power production, when once harnessed, does not depend upon the good will of labor organizations or the facilities commanded by transportation lines; its continuity of supply is beyond the influence of human agencies; it is regulated by Nature's laws only. It is not within the argument that this supply may be uncertain because of low-water condition, since it has been assumed that the boiler capacity is sufficient for the engine output, and that of the latter for the work to be done, so the assumption holds that the water-power development has been correctly planned in accordance with the available flow as replenishable from guaranteed storage.

A hydro-electric plant rarely causes delays due to repairs or renewal of parts. The generating part consists of water turbines, exciters, and generators. The first are practically automatic; at least they are known to have run continuously from beginning to end of year without stop or repairs; the generators are likewise complete in themselves, requiring no repairs; the transmission plant consisting of transformers and line brings the current to the shop and mill, and when it has been constructed with reasonable care, it is constantly serviceable. There are no mechanical drives of shafts, pulleys, and belts, each machine taking power from its individual motor. The wiring is permanent. The supply and service of a hydro-electric plant is therefore continuous and constant.

The second important feature in a power plant is its adaptability to the operation of shop or mill.

The steam plant must be located in close proximity to the work; it requires considerable space for fuel storage, boiler house, and engine room; it must be connected by tracks to some transportation system. In fact, the requirements of the power plant, not those of the industry, determine where it shall be located, and in many cases this condition is a positive disadvantage.

As to the application of the power itself, we have already mentioned the mechanical drive by which it is distributed, which practically fixes the arrangement of the machines and tools—irrespective of the demands of the process peculiar to the character of the work to be done—in straight lines parallel to the shafting. The presence of many pulleys and belts is a great hindrance to ready access to the apparatus, and the dust and droppings of oil make it difficult to keep the shops in anything like a cleanly condition, while the air is impure from the same cause and the great noise of all these operating fixtures does not contribute to orderliness and comfort. The speed for which a machine or tool is belted cannot readily be varied and, as a rule, it is not as high as could be utilized to advantage. Fast drives increase the output materially.

All this is different with electrical power; in fact, all these objectionable features are removed and advantages are added. The shop may be arranged absolutely to suit best the process; it may be, as is frequently desirable, divided into departments located in different buildings; each machine and tool has its individual motor—no shafts, pulleys or belts; no dust or uncleanliness, no noise or odors; each machine can regulate its own motor speed, the output is increased, and the shop may be expanded by adding tools whenever needed without regard to fixed arrangement of drives, as a wire splice is all that is needed to furnish power to another machine. The industry may choose the best location for its purpose, taking advantage of a desirable lot or rental of suitable building and, in fact, the enterprise may be planned without regard to power requirements.

Efficiency is the third consideration.

With steam power the efficiencies of boiler, engine and drive must be considered. That of the boiler depends upon the quantity of steam generated by one pound of fuel per hour, and the conditions influencing this result are quality of fuel, design of boiler, quality of water, and method of firing.

Many tests have been made of boiler efficiencies from which a considerable range in efficiencies, due to both fuel and to boiler design, is apparent, and to these must be added the other influences due to quality of water and method of firing—especially the latter, which largely controls the efficiency and depends wholly upon the care of the operatives.

The efficiency of the engine is the next factor; it is expressed by the quantity of steam required for the generating of one horse power, which depends upon the design of the engine, as securing the greatest amount of energy from the available steam and offering the least amount of mechanical friction. The source of the engine's work is steam pressure, which is in direct proportion to its temperature. From this is clear that the ratio of utilization of all the available pressure determines the efficiency. At best the range of temperature of steam is small, since it rapidly liquifies, which latter process is accelerated by its expansion. The important difference in engine types therefore deal with the conserving of the greatest quantity of steam pressure, which is greatly enhanced by condensation, after expansion in the cylinder. The two large classes of engines are therefore the non-condensing and condensing type, each of them being represented by many different designs and their efficiencies covering a wide range.

It is also proper to notice the effect upon engine efficiency exercised by the boiler, since the pressure or temperature of the generated steam supplied to the engine is the basic condition.

From many tests it appears that from 12.3 to 33.4 lb. of steam are required to produce one horse power per hour, depending entirely upon the type of engine, and this range may be furthermore increased by faulty conditions of engine parts or careless operation.

The third factor making up the efficiency of steam power for shop or mill operation is the mechanical drive, by which the power is transmitted and applied to the machines and tools. Some experiments by C. D. Gray, at Cornell University, show the following results:—

Power Application.	Efficiency of Drive, in per cent.
50 Cotton or Woolen Mills,	74
17 Machine Shops,	45
319 French Shops,	60
Wood and Metal-Working Shops,	65
Heavy Machine Shops,	55
8 Large Factories in U. S.,	56
3 Mills (full load),	56
6 Mills (half load),	45

These values are for the ratio of power taken from the shaft of the machines to that put on to the main shaft at the engine, and include only the loss in belts and shafts.

There is one other factor, and perhaps the most important in relation to efficiency of output, especially when considered in connection with operation of shops and mills; that is the constancy of efficiency under variations of load, and it is in this respect that the parallel here drawn is most seriously thrown out of balance. A steam plant's highest efficiency is that at full load, and it falls off rapidly with the decrease of load. For an engine of 1,000 horse-power capacity the following are the efficiencies with decreasing load:—

Load.	Output in Horse Power.	Efficiency, per cent.
Full,	794	79.4
Three-fourths,	544	72.5
One-half,	294	58.5
One-fourth,	44	38.1

The normal constant loss in belting and shafts is 206 horse power; and it must be borne in mind that this represents engine-output efficiency only, not that of the entire steam plant.

This closes the efficiency discussion of steam plants, though there are several minor influences tending to lower these efficiencies which it is not necessary to touch upon.

Contrasting with this exhibition the performance of a hydro-electric plant, it is first to be observed that the power value of the source of energy is fixed by the immutable law of Nature, that is by the product in foot pounds of the weight of water and its fall. It never changes; water weighs everywhere—for practical purposes—62.5 pounds per cubic foot, and this multiplied by the number of feet of its fall is the energy, and its efficiency as the energy source can therefore be fixed at 100 per cent,

The agency by which this energy is converted into mechanical power is today universally the water turbine. There are only two types, the reaction and the impulse turbine, their different characteristics being indicated by their names, though there are several known patterns of each, their chief difference being that they are manufactured in different shops; their characteristics are practically alike, variations being only of details of construction. This turbine, as the converter of the prime energy into useful work, takes the place of the boiler, engine, and all their appurtenant equipment, and it is complete in itself and the only and final mechanical device by which the mechanical power is produced.

The practical working efficiency of any of the modern turbines is 80 per cent, though much greater claims are made by the makers.

This mechanical power is converted into electric energy by the agency of electric generators which, in the large majority of cases, may be direct-coupled to the turbine shafts. There are two types of generators, the alternator and the direct-current machine, differing only as to their characteristic output of current, but for the purpose of this discussion only the first class need be considered, as the other is not available for transmission duty. There are various makes of generators, but their differences in design and character are even less pronounced than those of turbines. They are complete, with the addition of the exciter, in performing the conversion of mechanical into electric energy and their efficiency lies between 92 and 96 per cent.

This, then, completes the entire generating plant of hydro-electric power, with a net efficiency of 75 per cent of the prime energy.

Its application to the operation of shop or mill is by means of transmission of generated current which, within a distance of fifteen or twenty miles, may be accomplished without any further conversion of current characteristics or voltage, and therefore without other equipment excepting the transmission line, consisting of copper wire suspended from poles with proper safeguards of insulation. The loss of energy—drop of voltage—in this line may be from 5 to 10 per cent, which is entirely controllable by the size of copper wire in the line. And now the current is at the point of application to work, and is led to the machine or tool motors by a wire, and there represents the comparative efficiencies of 100 per cent of prime energy against the fluctuating heat value of fuel, and 68 per cent in working power of this energy as against 10 per cent developed by the engine out of steam.

The losses from this resultant electrical power in its application to useful work are those due to transforming, lowering its voltage, of about 3 to 5 per cent, and those in motors, about 4 to 7 per cent, leaving a net working efficiency of 88 to 90 per cent as against an efficiency in mechanical drive of from 45 to 78 per cent.

Last in the efficiency discussion is the constancy under varying loads which, as already foreshadowed, presents for the hydro-electric power an overwhelming advantage.

A water-turbine's rated efficiency is that of operating with three-quarter gate opening, and its range from that to full or half gate operation lies within 2 to 5 per cent, or in other words, the turbine's efficiency at any point between full and half load should not fall below 75 per cent. The same is true of the electric generator, which is especially designed to meet load fluctuations efficiently; the range of efficiency, from half to 50 per cent overload, will not be more than

10 per cent. The above claim of the remarkable difference in this respect between steam and hydro-electric power will readily be recognized by comparison of these losses and the losses quoted for decreasing loads in engines.

And now we reach the crucial, the most essential test of all, the cost of power. It is easy to foretell the factors which will be marshalled to proclaim the unquestioned superiority of hydro-electric power on this account. Cost of generating, operating, maintenance, depreciation of the actual output utilized and of plant are the main heads.

In considering these several features, to make a fair comparison, the parallel must be carried along one plane as to the character of the plants, which should be for the steam plant one of perfection of apparatus and equipment comparatively equal to that of an ordinary water-power plant. Turbines of today compare fairly in effectiveness of output only with the highest type of boilers and compound condensing engine plant.

It would be difficult to find another subject of importance to the industrial operator like that of the cost of his steam power, in regard to which he has less accurate knowledge. Of course the amounts paid for the boiler, engine, pumps, etc., and for coal and wages are known—but what about interest, water, taxes, insurance; about repairs, renewals, supplies and incidentals, and last but not least, depreciation? Are these items all properly charged? And most important of all, what is known of the actual horse power used, or in other words, the load factor of the shop? For all these items, apparently small, become large when the load factor fluctuates. It results, therefore, that far the most general impression is that the cost of power is about half the actual, or even less than that.

The generating cost is made up first, of fuel and water, the quantity and cost of which are as follows, at the very economical fuel consumption of 1.5 pound per horse-power hour and for 10-hour operation for 308 days;

Plant, Horse Power,	25	100	300	500
Tons of Coal,	57	231	693	1,155
At $2.00	$114.00	$462.00	$1,386.00	$2,310.00
" $2.50	$142.50	$577.50	$1,732.50	$2.887.50
" $3.00	$171.00	$693.00	$2,079.00	$3,465.00
" $3.50	$199.50	$808.50	$2,425.50	$4,042.00
Gallons of Water	140,000	567,000	1,702,000	2,836,000
At $0.10 per 1,000	$14.00	$56.70	$170.20	$283.60

The second item of cost is that of operating, being made up of wages, oil, waste, and disposal of ashes.

The operating force depends upon size of plant, but unless this is very small it will generally require an engineer and a fireman, and their wages will be about $90.00 per month for the former and $2.50 per day for the latter, being a total of $1,950.00 for the year.

Oil and waste is a somewhat uncertain item, depending entirely upon the care of the operators; it may be charged at $700.00 for a 500 horse-power plant per year, with a slightly decreasing ratio for larger and an increasing ratio for smaller plants.

Disposal of ashes is also an uncertain item; sometimes they can be used for fills and do not involve cost; in some cases they have to be carted off at some expense, but no charge will be made on this account in this instance.

Maintenance is the great unknown quantity. In this category must be placed all the repairs and renewals to buildings, stack, boiler setting, boiler flues and shell, furnace lining and grate; packing of pumps and engine, renewal of bearing linings, cylinder heads, and painting. $1.00 per horse-power per year during the first two years and a gradual increase of $0.50 per year thereafter is considered a normal maintenance charge under careful operation of plant.

Depreciation of plant is generally entirely ignored in estimating the cost; nevertheless there is very little doubt that the plant wears out, that boilers must be replaced by new ones in ten or fifteen years, that pumps and engines do not last forever. What is an old steam plant worth—what can it be sold for? Experience points to a depreciation charge of 5 per cent as a very conservative one on the type of plant here considered.

And then the vital item, the cost of actual output utilized, or, in other words, the ratio of cost of the power producing work to that of the entire output. A 250 horse-power engine requires its full capacity steam no matter what portion of its output is used; the full amount of coal is needed for generating the steam; the wearing and therefore maintenance and depreciation charge remains the same as does that of wages. If, therefore, only 125 horse power are doing work the cost of each horse power is that of 2 horse power generated. When the shop closes for the noon hour steam must be kept up, and indeed in most plants fires are kept up 24 hours for 10-hour operation.

There are no shops and few mills which represent a 100 per cent power load; the former will rarely exceed an aggregate of 60 per cent, the latter of 80 per cent.

The last item is that of plant itself. The cost of buildings, of course, is variable. Cost of boilers, set, is about as follows:—

Plain Tubular,	From	$12.00	to	$16.00	per	horse	power
Water-Tube,	"	15.00	"	20.00	"	"	"
Pumps, non-condensing,				2.00	"	"	"
Condensing,				4.00	"	"	"

The cost of engines is about:—

Simple Slide-Valve,	From $7.00	to $10.00	per	horse	power.
Simple Corliss or Slow-speed,	" 14.00	" 20.00	"	"	"
Compound Slide-Valve,	" 15.00	" 18.00	"	"	"
Compound Corliss,	" 22.00	" 26.00	"	"	"

Generating hydro-electric power does not require any fuel nor is the water in that sense a charge, as it pertains to the riparian ownership, and therefore it might be correctly said that there is no generating cost.

The operating cost is made up of wages, oil and waste.

For moderate sized plants the operating personnel consists of an operator, at about $90.00, and an attendant, at $60.00 per month, at the generating end, and a similar force at the distributing point. In this connection it must be borne in mind that such a plant as a rule takes the place of several individual steam plants. The quantity of oil and waste required will be considerably less than for a steam plant, as only the electric machines require lubrication. There are no ashes to be disposed of.

A realistic appreciation of the economy in operation of a hydro-electric power plant is forced upon any one who will visit such, as for instance, the plants at Mechanicsville, Massena or Niagara, representing a power output of from 20,000 to 100,000 horse power with from four to a dozen operatives. I designed and constructed the 50,000 horse-power plant at Sault Ste. Marie, Mich., which at present consists of an equipment of forty-two units of 500 electrical horse power each, with a turbine installation of one hundred and sixty-eight wheels. The operating personnel is made up of one superintendent, one operator, and four laborers. The power output, if steam, would require 378 tons of coal daily and probably one hundred men to handle it and do the firing.

The maintenance and depreciation of a hydro-electric plant is insignificant as compared with that of a steam plant. The works of modern construction are permanent and require no repairs or renewals; the turbines are of simple mechanism and no part of them is likely to wear much or to be injured; the electrical equipment is likewise durable, and the transmission line only is subject to damages from the elements, and therefore requires maintenance.

A summary of these items for a 1,000 horse-power plant is as shown on the following page in tabular form. The cost of operation is seen to be 25 per cent less for the hydro-electric than for the steam plant. And yet if anything, this comparison greatly favors the steam plant. Fuel consumption at 1.5 pounds per horse power hour is low for 90 per cent of steam plants; more frequently it is double that, and even greater, and maintenance charges grow rapidly as the plant ages.

Plant.	Steam.	Hydro-electric.
Buildings and Works,	$10,000.00	$40,000.00
Boilers, Pumps and Engine,	50,000.00	
Turbines and Generators,		15,000.00
Transmission, 20 miles,		40,000.00
Mechanical Drive,	5,000.00	
Distributing Equipment,		10,000.00
Total Investment,	$65,000.00	$105,000.00
Charges.		
Capital Investment, 5 per cent.	$3,250.00	$5,250.00
Fuel, $2.50 per ton,	5,775.00	
Water,	566.00	
Operation (three Firemen),	3,390.00	3800.00
Oil and Waste,	1,300.00	500.00
Maintenance and Depreciation,	3,750.00	3,200.00
Taxes at 2 mills,	1,350.00	2,100.00
Insurance,	650.00	
Total Operating Charges,	$20,031:00	$14,850:00

Applying ordinary efficiency of output, the cost per horse power at the machine per year, for the two systems, is:—

	Steam.	Hydro-electric.
At 100 per cent. load factor,	$25.50	$17.50
" 75 " " " "	36.90	22.90
" 50 " " " "	67.75	33.00

This is for shop power plants operating 10 hours; a similar tabulation for mills running 24 hours is:—

	Steam.	Hydro-electric.
Capital Investment,	$3,250.00	$5,250.00
Fuel,	11,550.00	
Water,	1,132.00	
Operation,	6,780.00	7,600.00
Oil and Waste,	2,600.00	1,000.00
Maintenance and Depreciation,	3,750.00	3,200.00
Taxes and Insurance,	2,000.00	2,100.00
	$31,062.00	$19,160.00

Here, again, the steam plant is quoted too low, as it must include extra boiler units to guarantee continuous operation. The cost per horse power per year will be, for

	Steam.	Hydro-electric.
100 per cent. load factor,	$39.12	$22.40

Thus far the discussion has concerned itself chiefly with the power plant of the individual shop or mill. Centralization of efforts and forces, of capital and organization, has been the keynote of the industrial development of the last decade, Central power plants are the logical application of the principle in the field we are studying. No other factor is so far-reaching in securing economical power as the displacing of the individual shop or mill plant and the substitution of central-plant service, which must be of electric current. By this evolution the industrial plant becomes emancipated from many of the serious disadvantages adhering to the individual power plant, which have already been enumerated in discussing adaptability, while it may enjoy the boon of paying only for the power actually used.

A central power plant is among the best assets of a growing town; enterprises can be established without considering the investment in a power plant, may be located without special regard to fueling facilities, and by their comparative cleanliness will attract a better class of operatives; nor is the influence on the sanitary conditions of the community to be minimized.

The electric current accomplishes all this for the shop and mill, and hydro-electric power is the ideal consummation for the central plant. A steam central plant is after all limited in its scope, while most water-power installations are capable of expansion by the addition of power units, the works being suitably designed.

It is quite likely that many of the readers of this article will hesitate to admit the plain conclusion that hydro-electric power represents the ideals of economy and perfection sought for in a greater degree than any of its rivals, and such hesitancy is warranted by obvious conditions. Only a decade or so has passed since hydro-electric power became a recognized rival of steam, and it is not remarkable that much that concerns it is yet enveloped in somewhat of a mystery. This fact is perhaps more sharply revealed to those who devote themselves entirely to its service, and therefore are constantly within the sphere of its influence.

It is certainly a fact that hydro-electric power development is today considered by many well informed men of industrial training and experience to be an experimental, uncertain, and speculative undertaking, characterized rather by chance and accident than reliability and permanency. In my judgment this impression prevails because the time since hydro-electric power has forced itself to the fore has been too short, its bringing out, so to speak, is too recent for men to take full knowledge of its character and of the required treatment to develop and control it successfully.

Water power, *per se*, has hardly ever received serious book treatment either from the commercial or technical point of view; such matter as has been published is scattered through text books, pamphlets, or manufacturers' catalogues; this is especially true of its history in the United States.

During its first period of utility, now well past, which may be termed that of the isolated mill power, developments required no searching investigations either as to supply or application; there was always sufficient water for the purpose, and if it failed at times it mattered little; the demand was represented by the mill. Nor did its planning call for special engineering skill. The works were of the crudest type and construction; they had low hydraulic efficiency, and the application was for an isolated mill, not a distributing power plant. These developments were good enough for their service, which did not call for refinements, economy and efficiency. Nor were these undertakings of large scope requiring important investments. The millwright planned and constructed them and little of his art got into public print; it was by the rule of thumb rather than scientific principles that they were created.

Then came the second period of water-power distributing plants, where conditions favoring the establishment of an industrial center near a large water-power opportunity existed. The works of these were important, were planned by engineers, and represent a high degree of excellence for that period. But, even then, little consideration was given to the securing of the greatest and most efficient hydraulic output obtainable from the available factors; the purpose was solely to distribute the water with the fall to separate industries, or to group the formerly isolated mills at one site. These undertakings were few in number, as the necessary favorable conditions were only rarely found in one place, and they concerned only large developments. Some of these were described in pamphlets and periodicals but no concise treatment of the subject as a whole came forth.

Then came the present period of hydro-electric developments, when water power is converted into electric energy and the output transmitted to distant points to perform any and all functions of applied power. It is no longer a question of mill sites, but of available distant market and a water power to supply its demands. Water powers never before considered now become eligible, first those of large outputs near important industrial centers, but as transmission problems have been more and more developed smaller powers have become available, until at the present time nearly every water power may find its useful field; hundreds are now under construction, other hundreds are projected for early development, and many more remain as yet unexploited.

In this, its present field, water-power development has assumed a new aspect differing materially from its former status. The purpose now is always to secure the largest, most economical, and most efficient development of the opportunity, which necessitates the correct estimating of the available power factors and the planning of a development by which the most remunerative output can be secured. Now it has passed into the specific realm of the hydro-electric engineer, on whose diagnosis of the hydrographic characteristics, estimate of output, designs of works, and equipment to the point of delivery, the success of the undertaking solely depends. Formerly the power site was fixed by mill location and operation facilities; now no such influence exists, and the power location may be and should be determined purely from the consideration of best development; this suggests a much more thorough search for the most favorable topographical and geological conditions and calls for the judgment which readily recognizes those natural features which influence the character and cost of development. The determination of the available flow is now one of the most important subjects, and its solution requires a correct appreciation of drainage-area characteristics, precipitation, evaporation, and the opportunities of storage.

Such an investigation was rarely a part of former water-power developments, and its importance is even now frequently overlooked. Therefore, it is the rule rather than the exception that the available flow is overestimated, especially for the preliminary stages, which constitute the period when the commercial value of the enterprise is first quoted. The result is disappointment, if not serious losses, when the later more thorough investigations fail to substantiate the preliminary estimates.

The works of these developments are now planned in accordance with the most modern scientific principles of conserving the greatest percentage of the power factors, and utilizing them by power agents of the highest obtainable efficiency, and in this sense the output must be planned for its ultimate purpose, the transmission of electric energy. The field now embraces hydraulic, mechanical, and electrical engineering, the study of the stream's hydrography, determination of the power factors, diagnosing the power opportunity, and deciding upon the most suitable development programme; and the planning of works and designing of equipment and of transmission plant. Thus has been developed a new specialty of engineering which has heretofore not been treated in one publication.

The promotion of hydro-electric power projects has been and is now being considered a fruitful field, and in the hurry and pressure, or for reasons of short-sighted economy, their exploitations have been very largely a matter of surface treatment resulting in erroneous and deceptive impressions. This experience is largely responsible for the want of confidence with which such projects are received by the conservative man of business and of capital.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By C. U. Carpenter.

IV. THE GREAT IMPORTANCE AND VALUE OF TOOL-ROOM REORGANIZATION.

Mr. Carpenter's series began in January last and so far has dealt successively with the mode of examining into the conditions of a manufacturing business so as to discover the "sticking points"; the institution and working of the "committee system," and the reorganization of the designing and drafting department. Next month he will take up methods and processes for machining operations and the determination of standards of efficiency in production.—The Editors.

IN the preceding article of this series, which appeared last month, I advanced the proposition that the essential preliminary step in the reviving of a run-down concern is the thorough reorganization of the designing, drafting, and tool rooms, along rather new lines. The necessary conditions to be secured in the first two departments were fully dealt with and the functions which the tool room should exercise toward the manufacturing processes at large were outlined.

In order, however, that the tool room, by its organization and equipment, may be enabled to lead the shop toward the goal of manufacturing success, it must itself be instituted for the highest efficiency and economy in the production of tools. I feel that too much emphasis can not be put upon the conception that this is the place to begin the work of reform, by close examination of the existing conditions and rectification of existing defects. It remains, then, to show how the maximum possibilities of the tool room may be realized. My suggestions are the result of experience in a number of very trying cases of factory inefficiency, and the remarkable results coming from the adoption of the plans described fully justifies strenuous insistence upon the statement that this is the real starting point for the campaign of improvement.

Tool-Room Methods.

The conditions surrounding tool-room work often make it difficult to apply the same methods toward the hastening and cheapening of production therein which might be applied to the production departments. Day pay is the usual rule. Owing to the character of the work, any other wage system is generally impracticable, and even if practicable would be inadvisable because of the necessity for accuracy.

Nevertheless, even granting the difficulties that beset one in trying to apply the principles of cheap production to this chief agent of progress and economy, the tool room itself—still, so high is the expense per man when compared with that prevailing in the balance of the shop, so costly may the tool-room product run, of so great importance is *rapid* production, and last, but by no means least, so many are the opportunities for "laying down on the job" without the possibility of detection of any such costly tendencies—that some comprehensive plans *must* be adopted, first, to ensure the cheapest possible methods of production, and, second, to check up foremen and workmen properly as regards costs and accuracy. If these points are properly covered, the *rate* of production will care for itself. Such a policy is especially necessary in the care of the run-down concern with an inefficient or "slow-gaited" tool-room force, whether the tool-room force is a large or small one. For, to state an important point which I shall want to emphasize, we must always keep in mind not only the possibility of wasted money through excessive tool costs, but also, and indeed *especially,* the waste of valuable time in securing tools by the use of which large sums can be saved in the shop.

We must, of course, assume that the tool room is supplied with a full equipment of high-grade machine tools.

First get a first class, high-grade tool-room foreman. This cannot be emphasized too strongly. Do not plan a campaign of improvement with any expectation of a satisfactory outcome unless this first step is taken. Well paid, high-grade mechanics are, in the end, the cheapest labor for the tool room. The mistakes of the low-wage workman are too costly. Owing to the high hourly rate of the tool maker, thorough organization in the tool room is necessary in the interest of low costs and rapid production of the tools themselves; but beyond this, is the great importance of getting the new tools into service. Delays are doubly costly, as already pointed out; and yet unless the tool room is well organized and systematized, it is often more productive of "unaccountable delays and disappointed hopes" than of the new and much needed tools. The dilatory movement of the ordinary tool room constitutes one of the most trying experiences of the factory manager.

In the older types of shop, even where large forces of tool makers are employed, the practice of allowing the expert high-priced workman to machine up and fit all the component parts of a single tool and then assemble it into the finished product still prevails. Under such conditions, this high-priced tool maker will be found machining up jig bushings, legs, special screws, and other parts of special tools that can be easily standardized, and in many cases will be turning out in small quantities work that should be handled on stock orders and turned out in large quantities by much cheaper labor at a fraction of the cost.

The similarity between this method of building tools and the old-time methods of building the finished machine for the market is striking. But just as the old-time method of construction in the case of the finished article was found too slow and costly for modern conditions of trade and competition, and has been rapidly supplanted by comprehensive plans for standardization, duplication, production in quantities and careful supervision of labor, just so the old-time tool room methods are being changed so as to take advantage of these obviously economical steps in the building of costly tools.

Standardization.—A tool-room force working under the old-time methods just described will produce in the course of a year sets of tools that are distinguished chiefly by a great lack of uniformity and absence of any attempt at standardization. Yet a close study of the ordinary shop tool conditions and requirements will prove that the standardization of many parts is possible if only a thorough-going attempt is made to effect it. This applies particularly to those shops where the tools are of the smaller sizes. For example, in the case of drill jigs, such parts as bushings, legs, stops, screws, pins—and even the bar stock—can be standardized to a comparatively few sizes.

Duplication.—Once this is done the duplication of these parts in quantities and the keeping of them in the stock bins for immediate use becomes possible. The savings are at once apparent. First, a large reduction in the initial cost results because of this production in quantities, and that too by a much lower priced workman than the tool maker. Again, the possibility of always having these parts on hand when wanted by this tool maker will invariably result in a large saving in both first cost and time.

Subdivision of Labor.—The modern practice tends therefore toward the same rigid subdivision of labor in the tool room that exists in the production department. The high-priced tool maker does no work that can be performed by cheaper men. Not only are those parts that can be standardized and machined in quantities produced by a less expensive class of labor, but also much of the closer work in milling, turning, grinding, etc., is often handled by special men who do no other classes of work. Thus the tool maker, instead of laboriously producing each and every part of any tool at great cost and loss of valuable time, becomes an expert adjuster and assembler, receiving promptly from various sources many portions of the tool he is to finish, these parts requiring simply the finishing operations at his skilled hands to bring them "to size."

In one large shop under my management, where conditions were unfavorable, we applied these rules of subdivision of labor and standardization to great advantage, especially in the building of large numbers of small drill jigs. The screws were standardized. All stops, legs, and other small parts were turned out in large quantities on the automatics. The bushings, also manufactured in large quantities, were turned into stock in such condition as to require simply the finishing operations by the experienced tool maker. Even the bar steel forming the top, bottom, and sides of the jigs, was finished to standard dimensions, cut off to standard lengths, and placed in stock for immediate use. The tool-designing department followed closely this scheme of standardization, the result being a large saving in tool costs, even though at times slightly more metal was used in the jig than was required by either the part to be manufactured or the character of the operation. This extra cost was saved many times over in the lower wage cost, due to the fact that the high-priced man had only a few finishing operations upon the component parts of the tool, and thus became an assembler and adjuster to a large extent.

In addition to this pleasing reduction in cost, there ensued a still more satisfactory increase in the output of greatly needed tools from a department handicapped by lack of room and of high-grade tool makers.

The Small Shop.

In the case of the small tool room of very few men such subdivision of work is often impracticable. But even in a department composed of four or five men, common horse-sense methods applied strictly to their work will result in a saving in both money and time that is of great importance and fully proportionate to the savings in the large departments. In shops where the tool-room force is a small one there usually exists a tendency to ignore this part of the organization and let it get along as best it can. This is a vital mistake. In the first place, the tool-room force is seldom half large enough considering the great value of its work. Again, the relative importance of this department in the case of the small plant is fully as great as in the case of the large company. Its work bears the same relation to cost, accuracy, and quickness of production in one case as in the other. Whether the department be small or large, the same methods of organization, division of labor, and of checking up tool costs can be used to great advantage.

METHODS OF INCREASING SPEED OF PRODUCTION AND CHECKING UP COST.

Lost time in the tool room, as already pointed out and emphasized, is a more serious matter than in any other department in the shop, since delay in the production of a tool means not only a high rate of increase in actual cost of that tool, but may often involve a continuation of a shop loss which could be avoided were the tool in use—a loss often many times the cost of the tool itself.

The importance of adopting up-to-date methods for increasing tool-room production and for checking up and lowering costs then seems obvious. And yet the lack of effort to accomplish these results in most well run modern shops (to say nothing of the poorly managed) is as singular as it is prevalent. The belief seems to prevail that the cost of a tool is too difficult a matter either to estimate or investigate. And yet the admission of the fact that it is a difficult question to solve makes the possibilities of loss in many directions the more apparent, the need for some method of removing them the more pressing.

The special conditions make the problem a hard one. The work is usually altogether special and must be done upon the day-work basis of pay. The difficulty of securing proper economical results from this day-work system often leads to lax methods in administration and management. The amount of time wasted by workmen under the day-rate system, unless they are rigidly supervised, is astonishing. Only an approximation to a "few days work" is often secured with difficulty. Even rigid supervision avails but little unless it is supplemented by some system that will prove a spur to the men—some system through the use of which the good men may feel that there is an opportunity for recognition and reward, and laggards may know equally well that if they do fail to produce work in a reasonable length of time they will surely be noted for punishment.

TOOL COST CARD.

The tool-room system advocated here depends upon the determination (by estimate) of the proper tool-room costs, item by item operation by operation, *before work* begins upon the tool; and then, after the tool is completed, the *comparison of the actual with the estimated costs,* and especially the noting of the records of the rapid and the slow workmen as shown upon the cards.

The card on the following page is self-explanatory.

Form of Card.—The form given is merely suggestive. In some cases, the division of "operations" is unnecessary. In other cases,

Tool Record Card

Tool No._______________ Drawing Nos._______________

____

____

Name of Part____

Name of Part of Tool	Operations	Estimated Costs	Actual Costs	Name of Workman	Remarks

Total Costs Labor____________________________________

" " Material____________________________________

Complete Cost____

This Tool must be completed by________________________

Date of Completion____________________________________

If any delay, Why ?

Special Instructions

Design and Estimated Cost Approved by

Tool passed by Committee______________________________

Sig. of Sec'y____________________________________

SUGGESTED FORM FOR TOOL COST AND RECORD CARD.

they are important. In most cases, the total time in which the work is actually done can be placed upon the card after the operation is completed; inasmuch as the man has before his eyes a statement of what *should* be done, he will know what he is accomplishing in the way of speed of production and he is certain that his record, be it good or bad, will "go up to the front office." Immediate and insistent inquiries as to causes and reasons for delay, when these occur, should invariably be made. Substantial benefits may be derived by offering to the men fair bonuses in case they secure a clean record of work done within the estimated time in the course of the week. This offering of bonuses removes the idea of "driving" which is so distasteful to many workmen.

Such a system, simple to the last degree, still is remarkably effective. Indeed, it is so effective because it contains, in simple form, the fundamental principles underlying all progressive methods of increasing shop efficiency, namely:—

(1) Determination of time in which work *should* be done.

(2) Placing it before the workmen themselves in definite form.

(3) Holding before them the chance for rewards in bonuses and promotion for record work, and the fear of reprimand or discharge in case of failure through carelessness, negligence, or laziness.

The question that immediately arises will be "Who sets the estimated time for the work and who checks up the actual time required?" I answer "The committee, as described in the February and March issues of this Magazine."

While the work of this committee will be varied, its functions many, still they will always relate to the one main object so ardently sought for—cheaper production costs.

Its members are vitally interested in the original cost of the tools and the rapidity with which they can be gotten through the tool room. These members are usually better qualified to estimate the length of time that should be required to build a tool of any description than any one man or group of men. After a short experience in estimating and checking up costs, they will soon become sufficiently expert to answer the purpose.

Method of Procedure.—After due consideration has been given to the tool model and the design of the tool itself, the estimate of cost of the tool should be determined and the record placed upon cards as noted. These cards should always be issued from and by this committee, so as to have the proper effect upon the workman. The card should travel with the work so that the workman may have a constant reminder beside him as to the time in which this body of men expect the work to be completed—a constant reminder that any failure to live up to the estimate will be surely noted upon this card and an explanation required—that his failure makes an indelible record against him which will infallibly be seen by those in charge of the shop and commented upon to his disadvantage—that a poor excuse for his failure will only blacken his record still further—that, on the other hand, any betterment of the estimated record will be noted with satisfaction by these same men and will surely redound to his credit. A first-class honest workman will be pleased at the opportunity afforded him of placing an evidence of his superior ability upon records which are lasting and which are noted by those high in authority with a view to future promotions. The loafer and sluggard will soon be detected and can be sought out for improvement or discharge.

Owing to the fundamental importance of the work of this committee and the fact that upon it hangs most of the burden of bringing the shop to a condition of high efficiency, a short *résumé* of its functions, mentioned briefly in the March issue of THE ENGINEERING MAGAZINE, may well be brought out at this point.

An outline of its province would be somewhat as follows:—

1.—Planning a new designs of product to meet new market conditions in such a manner as to ensure

  (a) Proper construction and accuracy of operation.

  (b) A course of manufacture that will result in the lowest possible cost of production.

2.—Planning the re-design of an old product in the interest of economy of production.

3.—Devising and considering plans whereby the shop production efficiency may be raised to a high point.

This involves:—

  (a) A close consideration of cost data so that the problem can be attacked at its most critical point.

  (b) The devising of full sets of special tools so as to make possible the attainment of the desired end of lower manufacturing cost.

  (c) The thorough consideration of these tools from the standpoint of design and *low production cost*.

  (d) Investigation of existing manufacturing conditions in the shop, and the careful planning of methods through which a high state of manufacturing efficiency may be

A SHOP COMMITTEE "IN ACTION." THE FOLDING BLACKBOARD WHICH IS A FEATURE OF MR. CARPENTER'S SYSTEM IS SHOWN ON THE RIGHT.

reached. This itself involves a thorough knowledge of the types of machine tools best adapted to the work, and the best results that can be obtained from them through the use of modern high-speed steel for the cutting tools—a big subject in itself concerning which there is still a lack of definite data.

(e) The determination of "standard time" (or the time in which each job of work should be done) on each job in the shop by calculation and test. This work is of an importance that can aptly be termed critical. It is perhaps the most important work of the committee. As I will explain in detail later, I do not consider that the committee itself should attend to the tests and the determination of the standard times, but the head of the tool room should actively direct the work under the strict supervision of this committee. The work, especially at its inception, should be constantly considered by this body in order to ensure proper results.

The cut of a "committee in action" may add interest at this point. Note carefully the important model of a new invention on the table, which, together with the detail drawings and cost data, is being thoroughly studied. In this case the new invention is receiving the careful, earnest consideration of these experts from every possible standpoint. The heads of important machining departments, the heads of the tool and designing departments, and the cost expert compose this committee. These men are considering this model from the standpoint of

(a) Design,
(b) Strength, ease and accuracy of operation,
(c) Ease of production and assembling of component parts,
(d) The most effective machining methods for quick, accurate and cheap production,
(e) The character and cost of tools best suited for the shop machinery and for the greatest economy in manufacture,
(f) The planning of machining operations for routine of manufacture for each part of the mechanism,
(g) The determination of the number of each piece that should be carried in stock and the most economical quantity to send through on each order,
(h) The approximate time required for each machining operation from the tools and the detailed preliminary estimate of cost.

A report covering these points, fully signed by each man, is sent to the manager, a copy to the designing and drafting department, and a copy to the head of the cost department, the committee of course keeping a copy for constant reference as the work on design, on tools, or on production progresses. Any necessary changes are considered by the committee for approval, and reports sent to proper parties. No change of any character will be for an instant tolerated unless it has the signed approval of the committee.

The folding blackboard (referred to in my article in February as an important adjunct to all committee meetings) will be seen to contain many notes referring to current work. As our men often say, "nothing gets away from that blamed blackboard." An order from the executive to consider and bring through to success any certain plan is placed upon the board and certain portions of the work are assigned to different men, these assignments being noted upon the board. *There each stays until it is accomplished.* I receive reports right "from the blackboard" showing progress made or lack of it. The character of the other reports of great importance sent directly to me by these committees has been fully treated in the preceding articles. The average manager needs no assurance as to the effectiveness of such a plan. It is a wonder worker.

TENDENCIES AND IMPROVEMENTS IN MARINE GAS-ENGINE CONSTRUCTION.

By Howard Greene.

The use of the combustion engine for marine propulsion is receiving increasing attention, and the broad principles involved were reviewed in our preceding issue. Mr. Greene's discussion is concerned with units of moderate size only, but brings out the most important points of recent progress in design and materials of construction. The assimilation to steam practice is specially interesting, and closely in line with the principles laid down in articles by Mr. Mathot, lately published in these pages.—The Editors.

LOOKING over the marine gas-motor field at the beginning of activities for 1907, one cannot fail to be impressed by the evidences of substantial progress that appear—not, perhaps, so much in the form of radical changes in individual cases as of a general tendency to adopt constructional forms and methods that have earned recognition as survivors of the process of eliminating the unfit, and to discard startling designs that possess no merit beyond the very doubtful one of distinct individuality.

The influence of the automobile motor, unquestionably harmful at first because of the extremes in light, high-speed, short-lived motors that followed its invasion of the sea, has almost disappeared, leaving, however, not a few important improvements such as *reasonable* weight reduction, the use of high-grade materials and the employment of high-class labor and manufacturing methods, refined and efficient carbureters and other fittings, and so on. But the day has passed when the automobile motor was transferred, with few changes, from the car to the boat, except in a few individual cases where extreme speed is sought; and manufacturers and users alike are opening their eyes to the fact that a motor will inevitably wear out faster if run at high speed than at a moderate rate—a fact that has persistently pushed itself forward notwithstanding all efforts to ignore it and to contradict the homely old saw about burning a candle at both ends. Extreme high speed and long life cannot be combined; no matter how slight wear may be, there is the inevitable argument that there would be still less if the speed were reduced. So we find that there is a prevailing preference for piston speeds that are quite moderate, and in some cases very slow, with the object of producing motors that will run and keep on running after the fashion of the good old steam engine, which keeps on working until it becomes a relic of antiquity and is finally relegated to the scrap-heap, still able to turn its shaft. And it is not surprising to note that the marine steam engine—that most highly developed form of the world's greatest prime mover—is furnishing the model for a number of gas-engine details. For instance, the closed crank case in four-cycle motors is frequently discarded for the well-known steel-column cylinder support or an arrangement of A-frames, sheet-metal guards stopping the flying of oil; the reliability of the steam engine, and a fair degree of its flexibility, are goals that have been practically reached by the leading builders and are sought by all.

Radical departures from what may be called standard design are found in those engines in which there are more power impulses per revolution than in ordinary two-cycle or four-cycle motors having an equal number of cylinders. The objects sought are, of course, increased flexibility, smoother running, and high power in proportion to weight, resulting from the greater evenness of turning moment and the decrease in the proportion of idle strokes; the discarding of the flywheel, and the ability for self-starting also usually follow in a motor in which the shaft torque is practically constant. The Standard 300 horse-power marine motor has six cylinders and is double-acting—that is, explosions occur on both sides of each piston, the piston rods being carried through stuffing boxes in cylinder heads and into crossheads, the whole being similar, in a general way, to current marine steam-engine practice and very different from the ordinary open-ended cylinders and trunk pistons of the usual gas engine. Each cylinder is thus approximately equal to two ordinary four-cycle engine cylinders, or to one two-cycle cylinder, and the crank shaft receives six impulses each revolution. No flywheel is used. Steam-engine design is strongly suggested in many ways, such as the crosshead and connecting-rod arrangement, the bed plate, and the steel columns on which the cylinders are carried.

Much more ambitious, so far as constancy of torque is concerned, is the Rice double-acting two-cycle engine, in which there is an explosion twice every revolution in each cylinder, the explosions occurring on opposite sides of a single peculiarly constructed piston. The effect is thus the same as in an ordinary double-acting steam cylinder; but, like ordinary two-cycle motors, the Rice engine has no valves and no moving parts except the pistons, connecting rods, and crank shaft. There is no flywheel. The operation of the engine will be understood on reference to the accompanying diagram of two of the four cylinders. The long vertical cylinder is divided into three parts;

the upper explosion chamber, the lower explosion chamber and, between them, the pumping chamber, the latter being formed by enlarging the middle diameter and making it eccentric to the explosion chambers. The piston is shaped to fit these three parts, and the eccentric section acts as the pumping piston and at the same time carries a rod, projecting upward through a stuffing box, which transmits motion to the long connecting rod through a crosshead. The pumping chamber is in communication with the carbureter through the usual intake piping, not shown, and with the explosion chambers of the adjoining cylinder through transfer passages. When one piston is at the bottom of its stroke the other is at the top, the cranks being set at 180 degrees. In the diagram, piston B has finished its down stroke. Its upper end has uncovered the transfer port from the upper end of the pumping chamber of the adjoining cylinder and fresh gas is flowing in, while the exhaust is escaping through exhaust ports of the ordinary type, omitted from the diagram to avoid confusion. The upper end of piston A has compressed the charge received on the preceding stroke and is ready to explode it for the downward power stroke. Precisely the same conditions obtain in the other cylinder, B, though at opposite ends of the cylinder. This particular engine is experimental and differs in several details from the regular models now in course of construction. For instance, it will be noticed that two explosions occur simultaneously at opposite ends of adjoining cylinders. This is the result of the crossing of the transfer passages so that the pumping

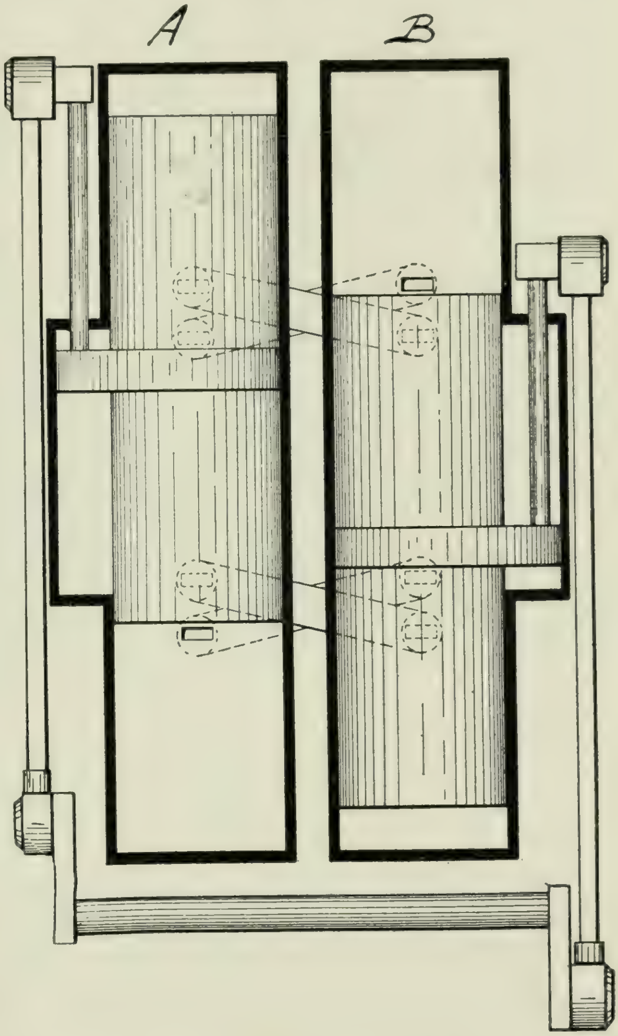
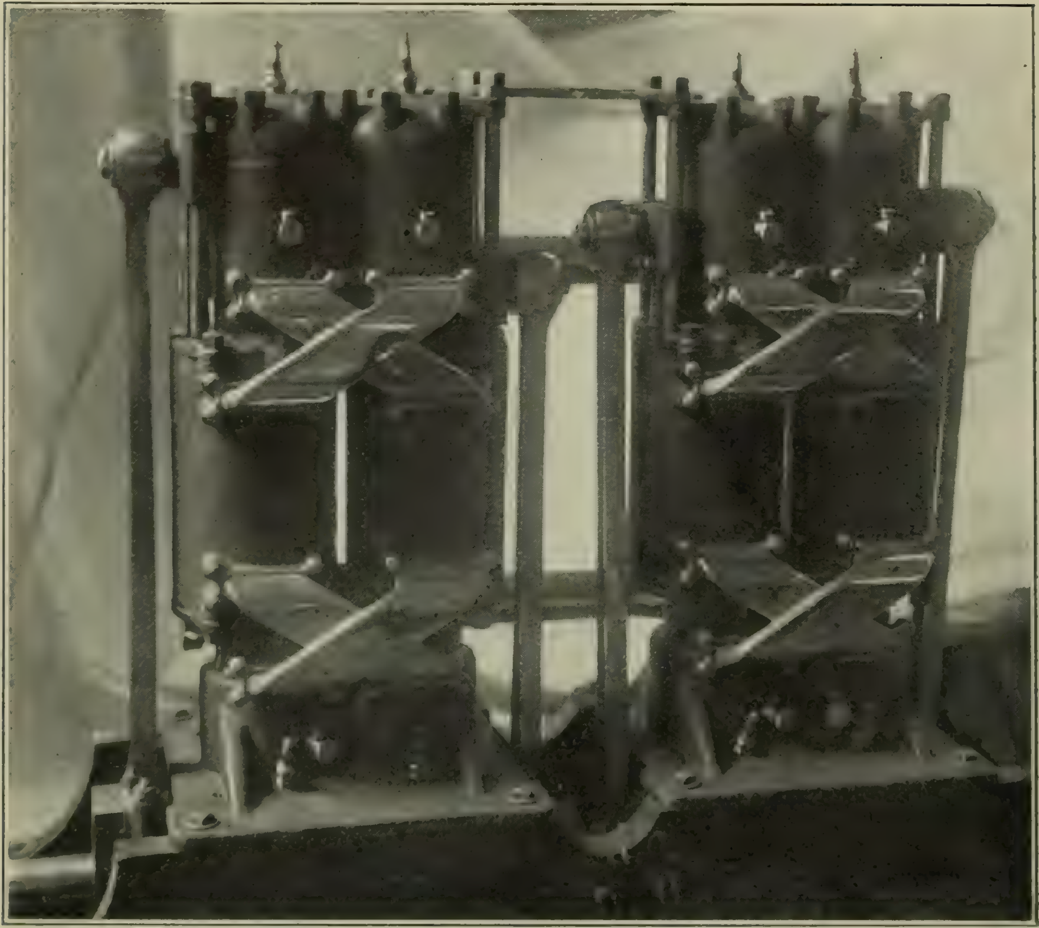


DIAGRAM SHOWING PRINCIPLE OF OPERATION, RICE TWO-CYCLE DOUBLE-ACTING ENGINE.

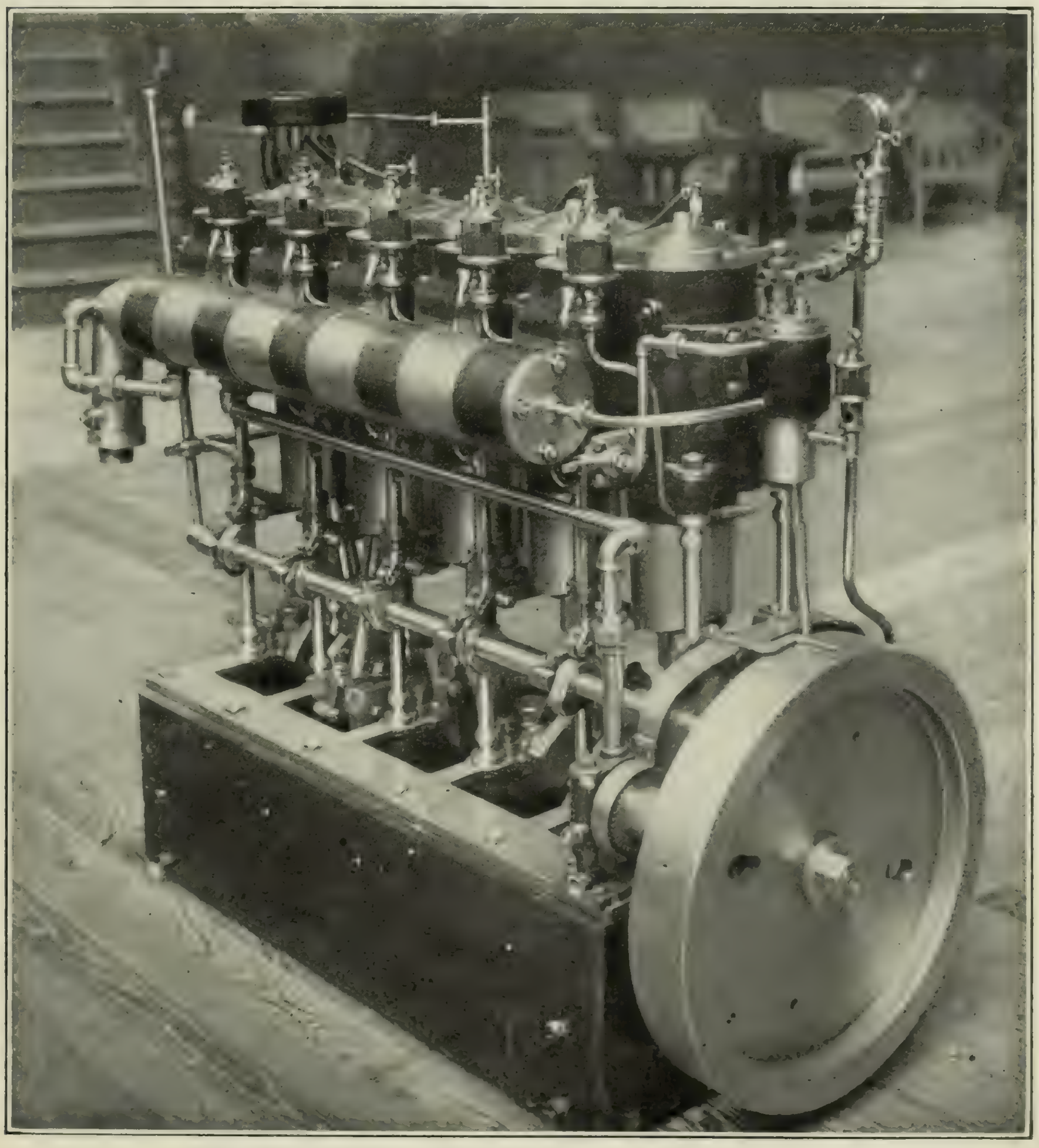


RICE TWO-CYLINDER DOUBLE-ACTING ENGINE.

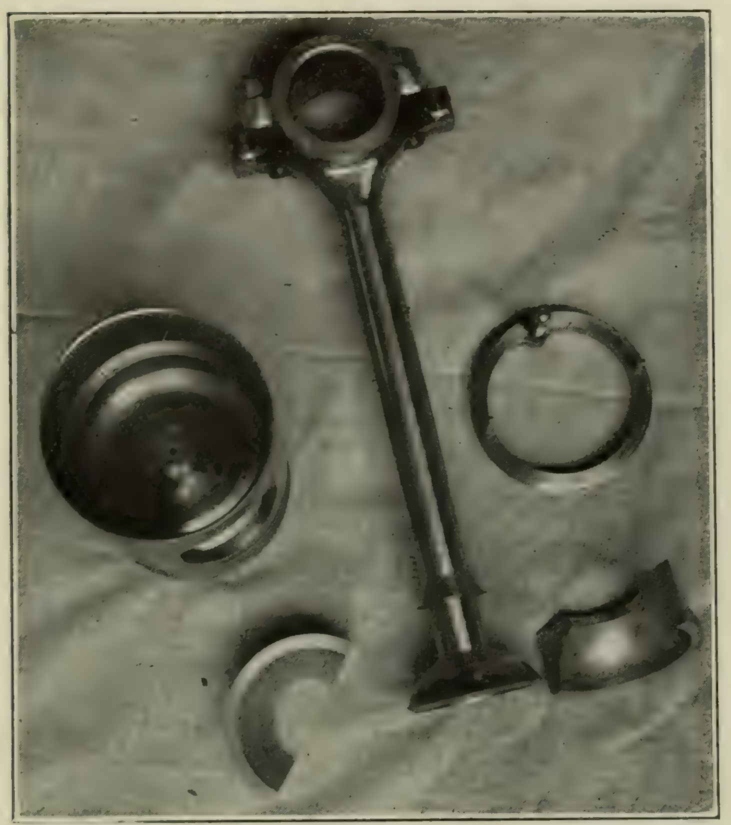
Explosion chambers in both ends of cylinders. J. V. Rice, Jr., & Co., Bordentown, N. J.

chamber in one cylinder serves the explosion chambers of the other. In the new models each cylinder is a separate unit, the pumping chamber serving the explosion chambers in the same cylinder. The cranks of a four-cylinder engine can be set at 90 degrees and the shaft will receive an impulse every 45 degrees, or every quarter of a revolution. Six-cylinder motors are also being built, which will have twelve impulses per revolution, or one every 30 degrees. This form of construction avoids piston rods and stuffing boxes subjected to the heat of combustion; the ends of the cylinders are closed; connecting rods are long, and all working parts are exposed. Weight is kept down and the mechanical balance is good. The side thrust of the pistons, due to the method of transmitting motion to the connecting rods, is said by the manufacturers to be not more than 3½ to 4 pounds per square inch; the thrust of the ordinary trunk piston may be placed at from 12 to 15 pounds to the square inch. In the new models the height of the cylinders has been decreased about one-third. A number of these motors are to be installed in self-propelled railroad coaches by a railroad company; the railroad-engines will have six cylinders and develop 100 horse power.

While the more daring designers undertake the exploration of comparatively fresh fields, the majority conservatively confine their efforts to the improvement of existing designs. A striking example of this is the Dock four-cycle engine. This engine has five cylinders and the cranks are spaced 72 degrees apart; the stroke is very long, for a marine gas engine, being 8 inches, while the bore is 4½ inches. The four-stroke cycle is employed; the valves, symmetrically arranged on opposite sides of the cylinders, are all mechanically operated. The most interesting feature of the engine, however, is the self-starting device. At one end of the engine is a piston air pump,



DOCK FIVE-CYLINDER FOUR-CYCLE SELF-STARTING MOTOR.
N. Y. Safety Steam Power Co., Hope Valley, R. I.



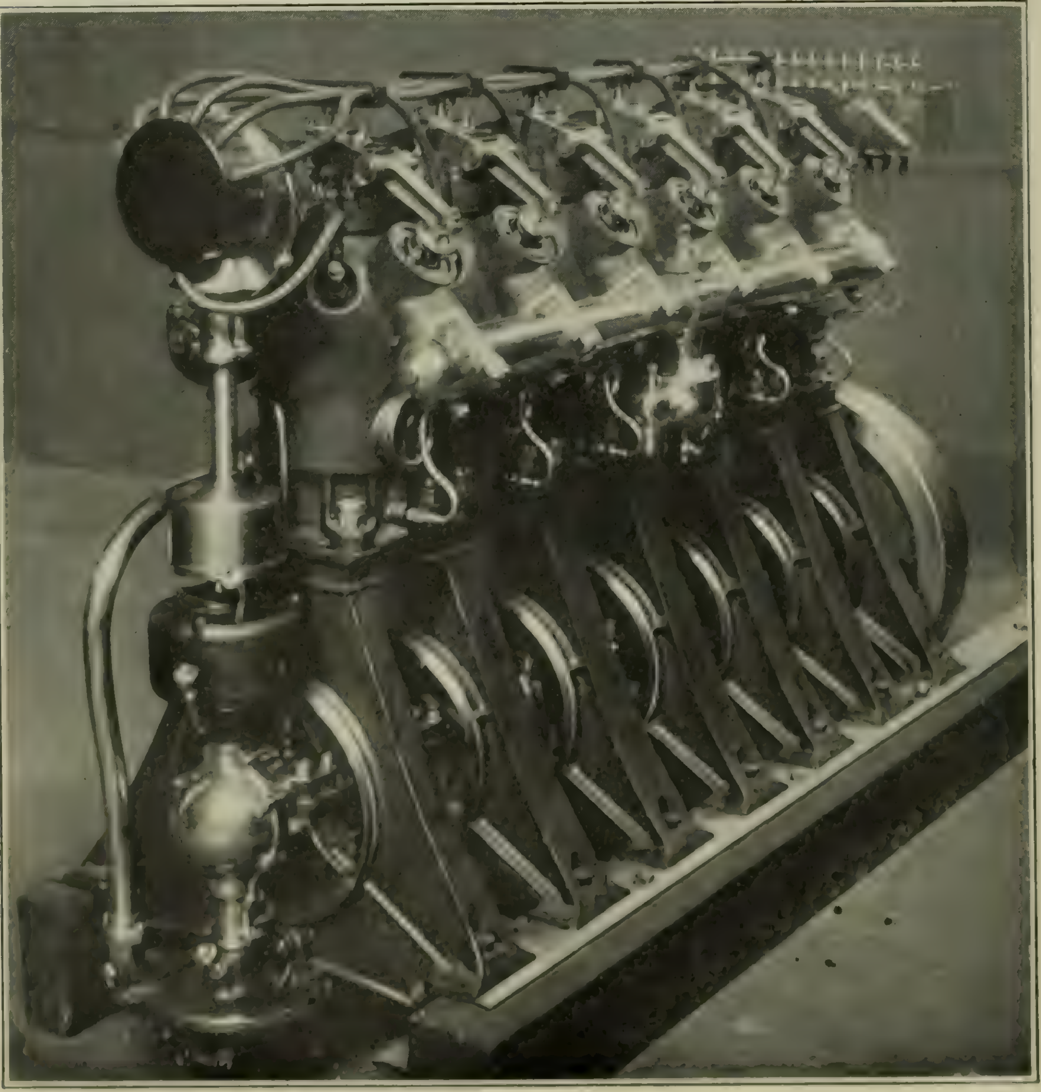
PISTON, CONNECTING ROD AND CUP-AND-SOCKET JOINT OF DOCK ENGINE.

driven from one of the valve gears, which delivers air under pressure to a receiver placed in any convenient position near the engine. Only a small receiver is required, as the air pressure is called upon only to move the engine through a small part of a stroke. The starting is effected as follows: a valve is opened, permitting air to pass to the engine by way of the carbureter, where it takes up sufficient gasoline to form an explosive mixture. This mixture under pressure naturally passes into the cylinders whose inlet valves are open and whose pistons have therefore commenced the down stroke. These pistons are given an impulse by the compressed air, and the pistons in the other cylinders in which there are charges of combustible gas are forced up until the compression is completed and the point of ignition reached, when explosion takes place and the engine commences to run in the usual way. The cylinders to which the compressed carbureter air was admitted are of course filled with explosive charges of gas, and this gas is compressed and ignited in the regular order, there being no useless air to get rid of before a combustible charge can be admitted. This makes it possible to start the engine under load, an operation which is considerably simplified by the comparative constancy of the torque resulting from the use of five cylinders.

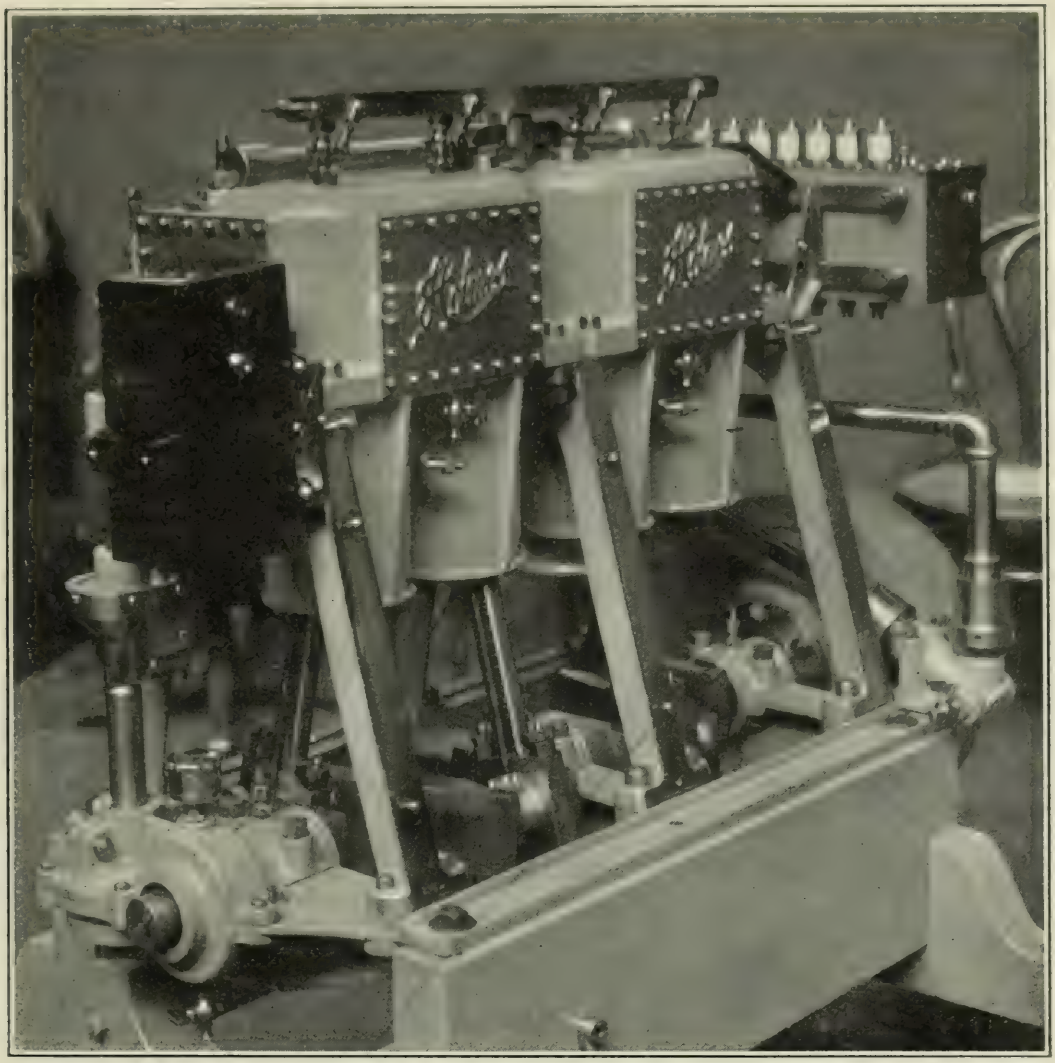
As there is nothing to hold the inlet valves on their seats except the compressed helical springs, they would, if closed, be lifted by the inrushing air of the self-starting device, if no preventive means were supplied, and the pressure, admitted to the pistons on the up-stroke, would counteract the downward pressure on the other pistons and so prevent self-starting. So a very ingenious arrangement of the valves is adopted. The valve stem passes through and slides easily in a small piston fitted into the under side of the valve housing. A flange on the bottom of the little piston limits its upward movement, and it is normally held as high as it will go by the valve spring compressed between the usual key on the valve stem and the lower face of the little piston. When the engine is running the valve works in the usual way, the piston being inoperative. If, however, the valve happens to be closed when the starting device is brought into play, the compressed air, acting on the upper surface of the piston, forces it down and further compresses the spring, effectually preventing the lifting of the valve from its seat. The cam will lift the valve, however, regardless of the increased spring pressure, when the proper time arrives. A check valve in the pipe through which air is drawn while running is closed automatically by the pressure of the starting air, but opens as soon as this pressure falls to atmospheric.

The connecting rods of the Dock engine are attached to the trunk pistons by means of cup joints instead of the usual wrist-pin arrangement. The upper end of the rod is enlarged and is hollowed to a cup shape, accurately spherical, and a corresponding projection on a diaphragm in the piston accurately fits into the cup. The outer surface of the cup on the rod is concentric with the inner surface, and a loose cup, made in halves, is placed over it and held in place by a screw collar. The collar is split at one side and a tapered screw is fitted to force the ends apart at the split and so, by friction, lock the collar firmly in place. This, of course, makes it a simple matter to take up all wear. The two principal advantages of this arrangement are that a very large bearing surface is provided, and that the piston is free to turn on its axis and equalize the wear on both piston and cylinder.

An engine that is typical of present tendencies in four-cycle marine practice is manufactured by the H. & H. Engine Company, in three sizes having cylinder dimensions of 4¾ by 5½, 6¾ by 7, and 8¾ by 8½, the maximum rated horse powers being 38, 77, and 160 horse power respectively. These ratings are based on a piston speed of 750 feet a minute. The three sizes are exactly alike in design, so that the photograph, which shows really the smallest engine, will illustrate the larger engines equally well. The practice of carrying all the valve gear above the cylinders is rapidly increasing in marine engines. In the engine referred to the cam shaft is carried in bearings bolted to the cylinder heads. The valves, all mechanically operated, are set into the cylinder heads with their stems at an angle of 45 degrees from the vertical, and each is operated by its individual rocker arm pivoted to lugs cast on the iron boxes that at the same time form housings for the cams and carry the bronze bushings for the cam shaft. Cam thrust is taken by hardened steel rollers on the cam ends of the rocker arms. The cam shaft is rotated by bevel gears on a vertical shaft, bevel-gear driven from the end of the crank shaft. This vertical shaft extends below the crank shaft and carries at its lower extremity the centrifugal water pump; the pump is so placed that when the engine is installed in the boat it will be below the water line and therefore self-priming. On the vertical shaft between the two pairs of bevel gears is the generator which furnishes the current used for ignition when the motor is running. The six cylinders are carried by seven A-frames of cast



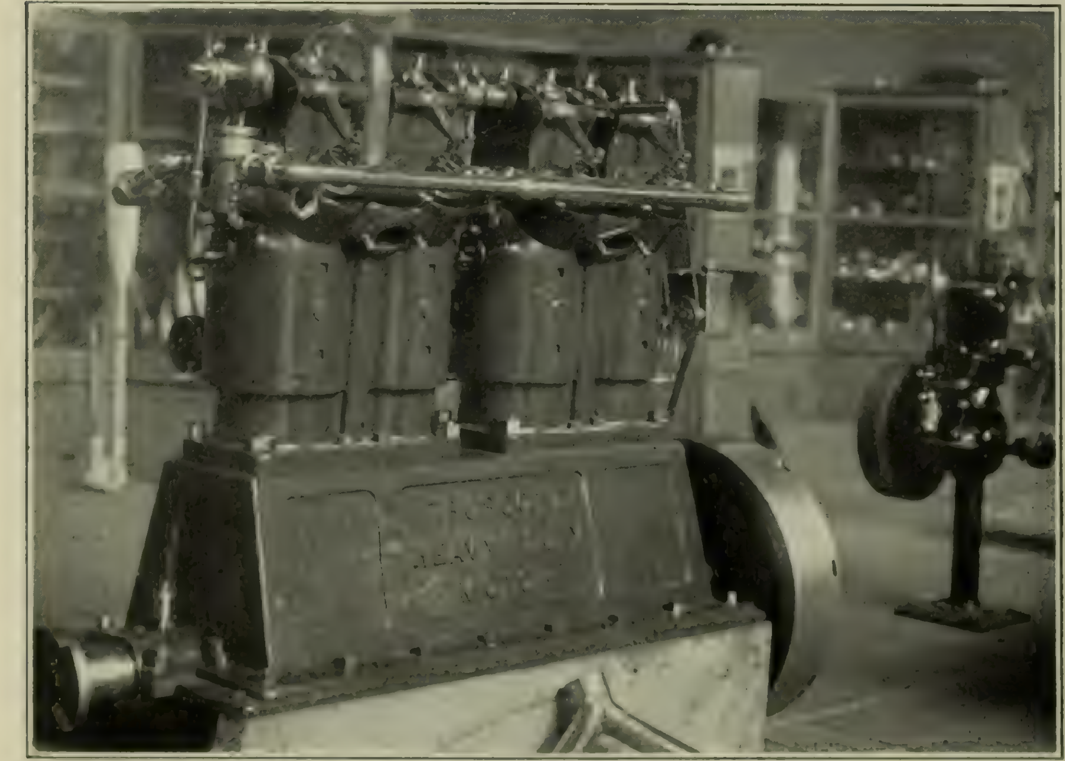
HURD & HAGGIN SIX-CYLINDER MARINE ENGINE, OVERHEAD VALVE GEAR.
Hurd & Haggin Engine Co., N. Y.



HOLMES LONG-STROKE LIGHT-WEIGHT MARINE MOTOR, CAST BRONZE FRAMES.
Holmes Motor Co., West Mystic, Conn.

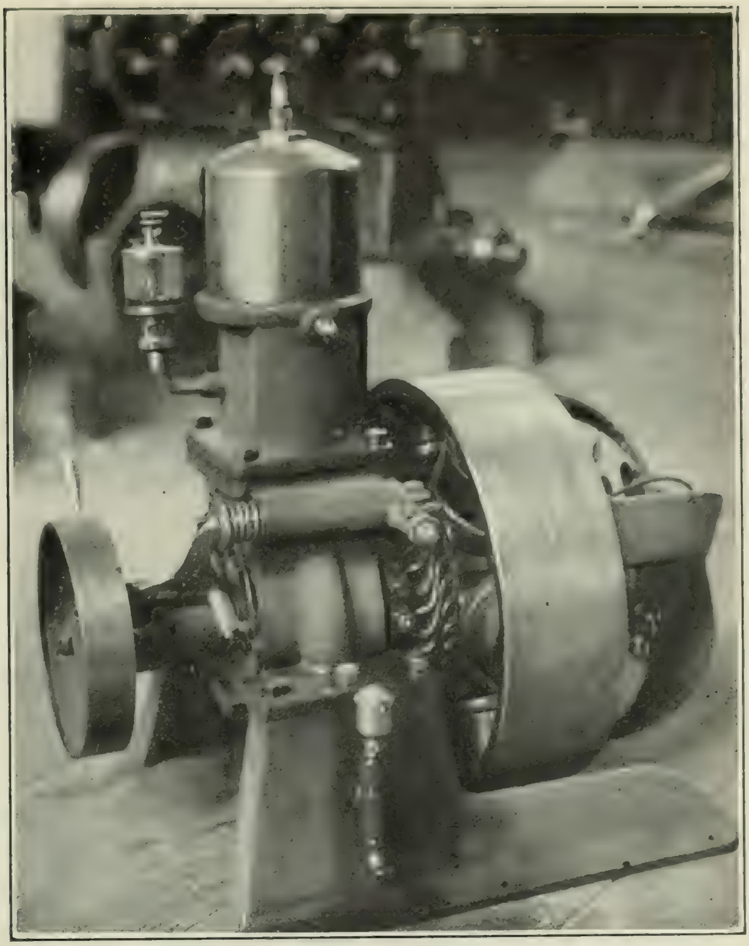
steel; a large opening in each frame is bored out truly circular and the cast-steel brackets carrying the bronze split bearings are turned to a similar radius. This work is done with great care, so that when the parts are assembled they will go together in alignment, without requiring a long course of hand fitting. The lower parts of the bearing brackets are hollow, forming oil cellars, the oil being lifted to the shaft and bearing by oil rings of the usual type. The bases of the frames are bolted to longitudinal steel Z-bars of standard section.

A rather unusual combination of light weight and moderate piston speed is found in the motors built by the Holmes Motor Company. These are four-cycle motors with open bases and light cast-bronze frames supporting the cylinders, cast in pairs, which are carried down well below the point of support in the form of light tubes, a stiffening rib on each side running up to the integrally cast water jacket. The valves are all carried in housings cast on the sides of the cylinders, their stems extending downward, and the cam shaft is on a level with the lower ends of the cylinders, running in three bearings bolted to the A-frames. A vertical shaft and bevel gears drive the cam shaft and, extending upward, the vertical shaft carries the timer. The water jackets are formed by plates screwed to light frames cast on the cylinders. The builders of this engine have worked out the details with a view to the utmost accessibility, and tests have shown that two men can take the entire engine apart and put it together again in a trifle more than an hour. Engines of this type are being furnished by the Holmes Company to the United States Government.



HEAVY DUTY FOUR-CYCLE MOTOR, OVERHEAD CAM SHAFT DRIVEN BY ENCLOSED CHAIN.
Truscott Boat Manufacturing Co., St. Joseph, Mich.

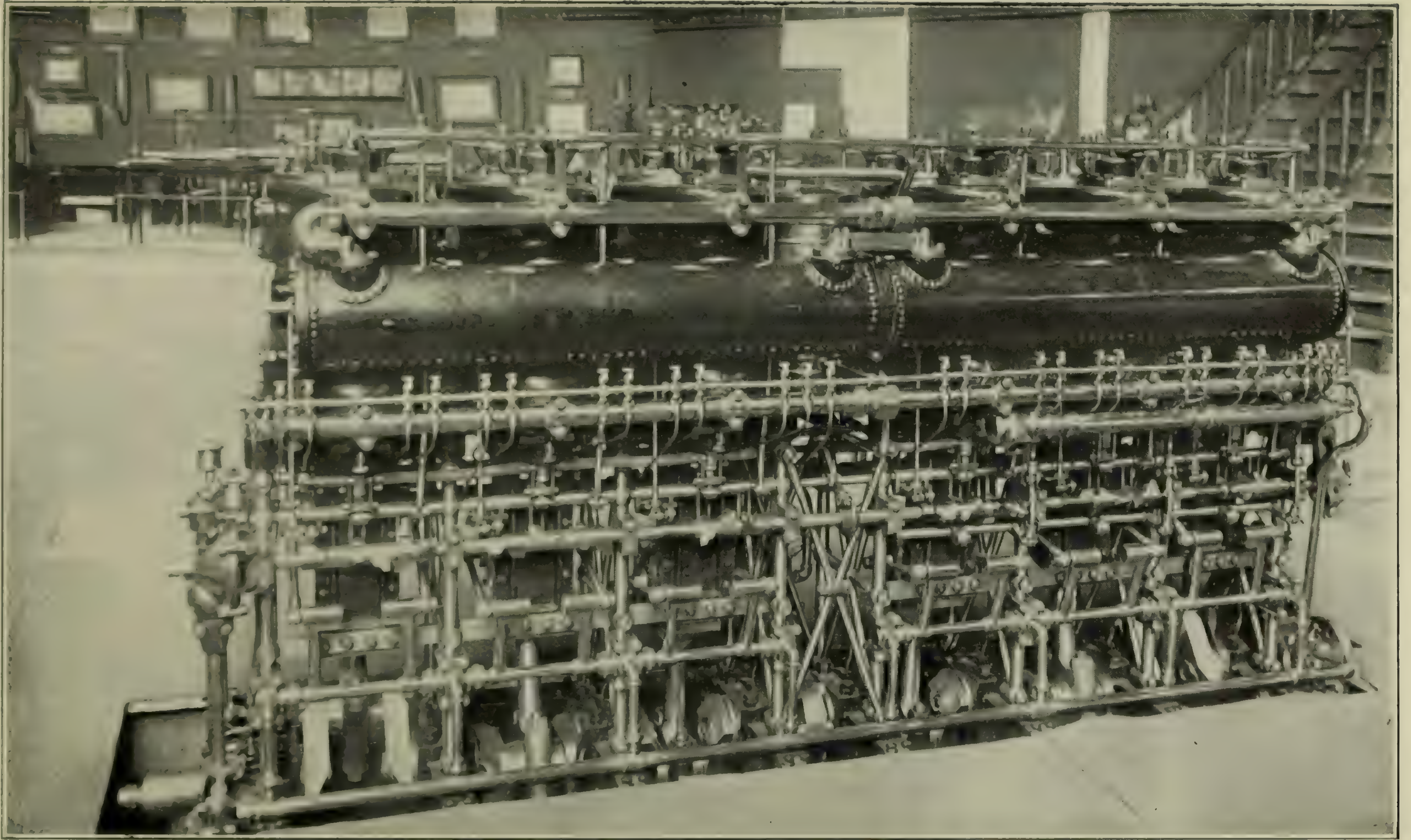
Another engine employing overhead valve gear is the new model four-cycle Truscott, but an unusual method of driving the cam shaft is adopted. Instead of a shaft with bevel gears, a chain is used, running from a sprocket on the crank shaft, between the after cylinder and the next one, to a sprocket having, of course, double the number of teeth, on the cam shaft. The cylinder casting is made with an integral housing for the chain to run in, and at the top both chain and sprocket are covered by a removable brass casing. The valves,



TRUSCOTT SELF-CONTAINED ELECTRIC-LIGHT SET.

exhaust on one side and inlet on the other, are operated by rocker arms with steel rollers to relieve cam friction. Ignition is by make and break, the trips being actuated from eccentrics on the cam shaft; the time of ignition can be varied by giving the eccentrics more or less lead by means of a rod running through the cam shaft and rotating with relation to the cam shaft, carrying the cams with it, when moved longitudinally by a fork and collar arrangement controlled by a handle. Jump spark ignition can also be fitted. The same company has brought out an electric-lighting plant for yachts—or for that matter, for any purpose where a small plant is required—consisting of a two-cycle single-cylinder motor direct-connected to a direct-current generator with a capacity for feeding fifteen 16-candle-power 110-volt incandescent lamps. The floor space occupied is 18 by 22 inches and the weight 200 pounds. The field rotates about the armature and serves as a flywheel for the motor; a sensitive governor acts on the throttle, regulating the amount of gas taken into the cylinder at each stroke; or else the governor is adapted to act on the ignition, which is of the jump-spark type.

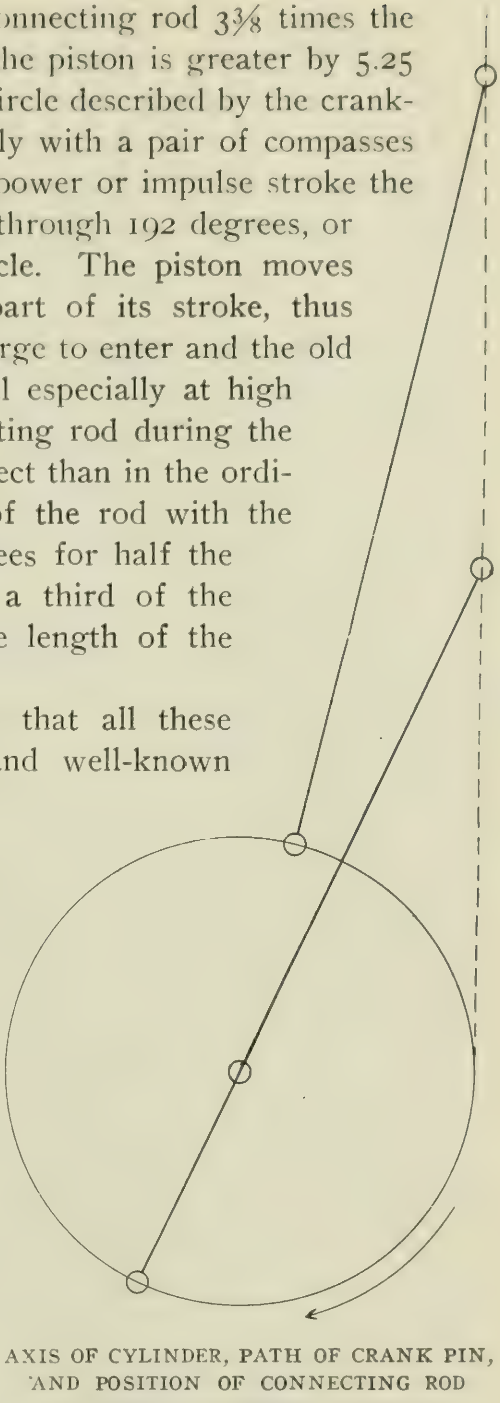
Among other 1907 types may be mentioned an interesting little two-cycle motor, built by the Ramsay Manufacturing Company having the cylinder offset from the crank shaft a distance equal to the crank length, or half the stroke of the piston. In other words, the axis of the cylinder is tangent to the path of the crank-pin center.



STANDARD 300-HORSE-POWER GASOLINE MARINE ENGINE, FOUR-CYCLE DOUBLE-ACTING.
Water-cooled pistons and piston rods; started by compressed air. Standard Motor Construction Co., Jersey City, N. J.

The result of this is that with a connecting rod 3⅜ times the length of the crank the stroke of the piston is greater by 5.25 per cent than the diameter of the circle described by the crank-pin; this can be proved very readily with a pair of compasses and a diagram. Also, during the power or impulse stroke the crank pin is subjected to pressure through 192 degrees, or 12 degrees more than half a circle. The piston moves very slowly through the lower part of its stroke, thus giving ample time for the new charge to enter and the old charge to escape; this is beneficial especially at high speeds. The thrust of the connecting rod during the power stroke is of course more direct than in the ordinary type of engine; the angle of the rod with the piston is slightly less than 3 degrees for half the piston stroke, and 1 degree for a third of the stroke, with a rod four times the length of the crank.

It is hardly necessary to say that all these features are more or less old and well-known to engineers; but their application to marine gas engines of the latest types is of no little interest—especially in view of the favorable results that have followed the use of these designs in actual service. It is a significant fact that most of the motors employed in self-propelled gasoline railroad coaches—of which a number are running and still more are contemplated or actually under construction—are of the marine type; and it is also interesting to note that the up-to-date gas motor has found its way into such exacting service as that of propelling life-boats, government inspection boats, and so on, proving, if proof be required, that the gas motor of today is a very different machine from the whimsical, unreliable affair of a few years ago.



AXIS OF CYLINDER, PATH OF CRANK PIN, AND POSITION OF CONNECTING ROD AT ENDS OF STROKE, RAMSAY OFFSET-CYLINDER MARINE ENGINE.

COST REDUCTION THROUGH COST COMPARISON.

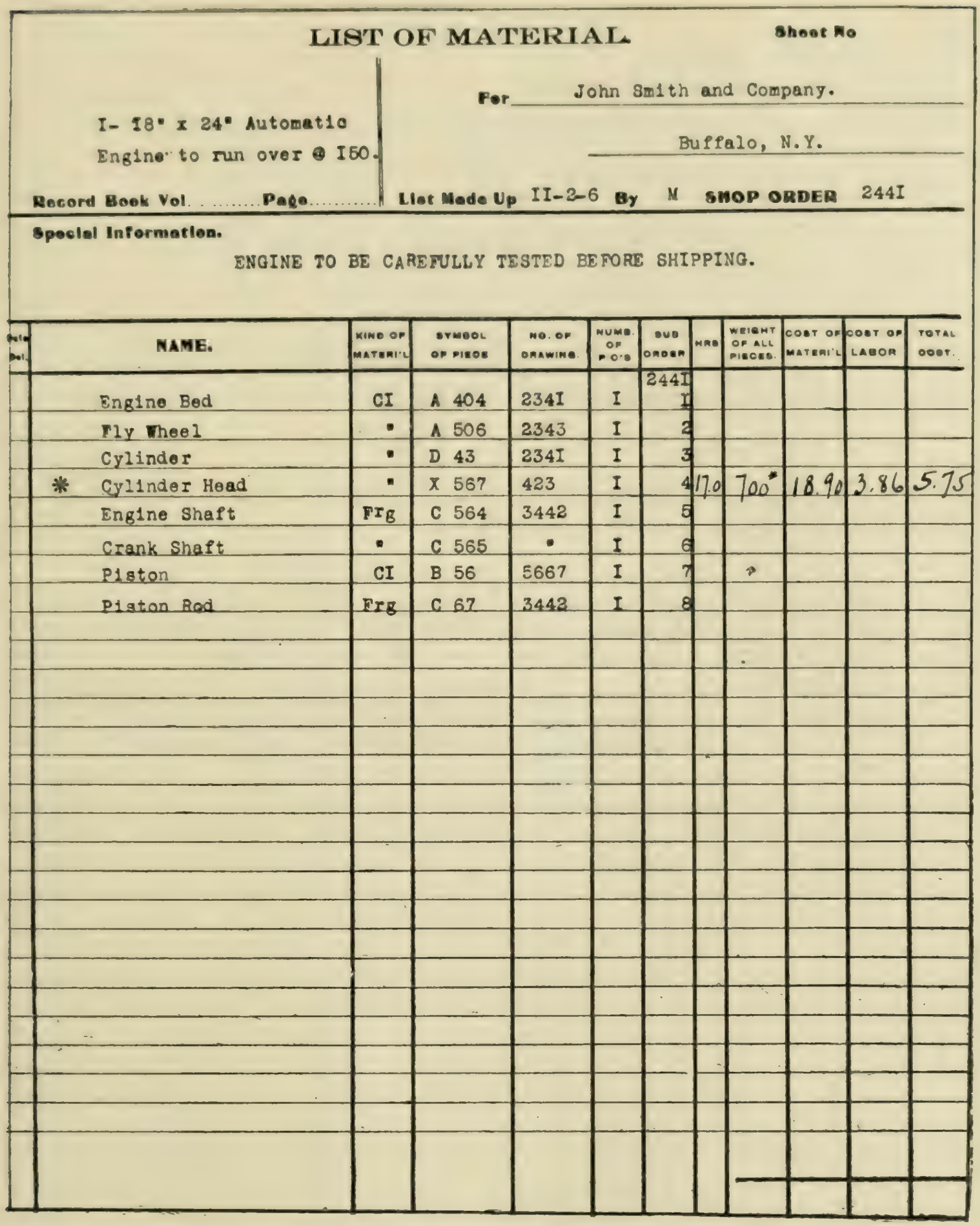
By C. E. Knoeppel.

Mr. Knoeppel's preceding article, in our March issue, discussed cost-comparison methods as applied to overhead burden and general expense. A concluding paper, next month, will outline the formation and working of a department of cost comparison.—THE EDITORS.

II. THE TREATMENT OF MACHINE, PART, GROUP, AND OPERATION COSTS.

IN the struggle for commercial supremacy, the desire and ambition of all who are at the heads of manufacturing enterprises is a maximum output at a minimum cost, and it is safe to say that much time and attention is given to the attempt to realize this ambition. At the present time, far-sighted managers are taking into consideration the fact that not only is labor from time to time seeking larger wages per day, but that the tendency of the raw-material markets is upward. They fully realize that unless these increases in their prime costs can be offset by either higher prices or an increased production, a reduction in the profits and dividends is sure to be the result. In many lines, competition is so severe as almost to eliminate the possibility of securing an increase in the prices, so that any equalization in profit must be brought about by a reduction in the costs, through an increase in the production. It will be found even in those cases where prices can be advanced that the desire is to secure an output costing as little as is consistent with good workmanship and material, so that in either case the end in view is "Cost Reduction."

In a preceding article, I endeavored to show how "burden costs" could be reduced; it is the purpose of this article to show how operation, part, group, and machine costs can be so compiled and classified as to facilitate comparison—the secret of cost reduction. It is true that in some cases excellent work has been done by shop managers along the lines of reducing shop costs, but maximum efficiency can not be secured unless the shop and office management work together. If a shop foreman could remember the time and money spent on each part or operation each day for the year he would be entirely independent of the office, in so far as the ability of the office to give him data regarding the efficiency of his men is concerned; but as this is im-



LIST OF MATERIAL. **Sheet No**

I- I8" x 24" Automatic
Engine to run over @ I50.

For John Smith and Company.
Buffalo, N.Y.

Record Book Vol. .... **Page** ....
List Made Up II-2-6 **By** M **SHOP ORDER** 244I

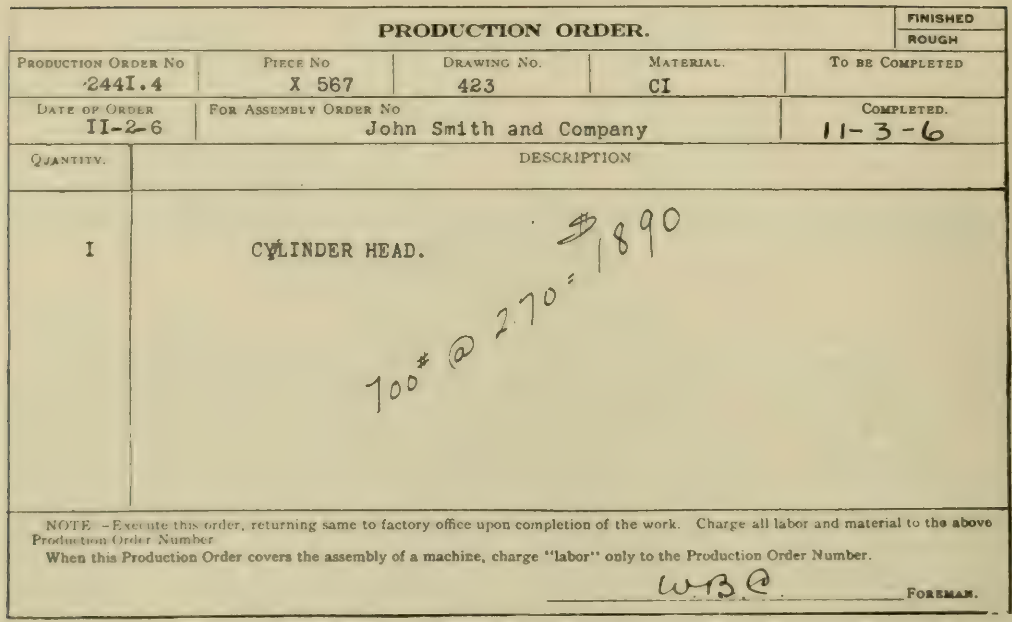
Special Information.
ENGINE TO BE CAREFULLY TESTED BEFORE SHIPPING.

	NAME.	KIND OF MATERI'L	SYMBOL OF PIECE	NO. OF DRAWING.	NUMB. OF P'C'S	SUB ORDER	HRS	WEIGHT OF ALL PIECES.	COST OF MATERI'L	COST OF LABOR	TOTAL COST.
	Engine Bed	CI	A 404	234I	I	244I I					
	Fly Wheel	"	A 506	2343	I	2					
	Cylinder	"	D 43	234I	I	3					
	* Cylinder Head	"	X 567	423	I	4	17.0	700*	18.90	3.86	5.75
	Engine Shaft	Frg	C 564	3442	I	5					
	Crank Shaft	"	C 565	"	I	6					
	Piston	CI	B 56	5667	I	7					
	Piston Rod	Frg	C 67	3442	I	8					

FORM A. LIST OF MATERIAL. THE FIRST RECORD FORM FOR A NEW ORDER. Thin white paper, 8½ by 10½ in. On this is listed every item going into the construction of the engine; on the sample above only a few items are entered by way of illustration.

possible he must depend upon a system devised to meet existing conditions.

The measure of a shop manager's ability is not merely the number of pounds of material shipped during a month. His ability to secure a maximum output might go unquestioned, but this maximum output might have cost the company a maximum amount of money. A shop manager in order to be classed as successful must secure a maximum



PRODUCTION ORDER.

FINISHED	
ROUGH	

Production Order No	Piece No	Drawing No.	Material.	To be Completed
·2441.4	X 567	423	CI	

Date of Order	For Assembly Order No	Completed.
II-2-6	John Smith and Company	11-3-6

Quantity.	Description
I	CYLINDER HEAD. $1890 100# @ 2.70

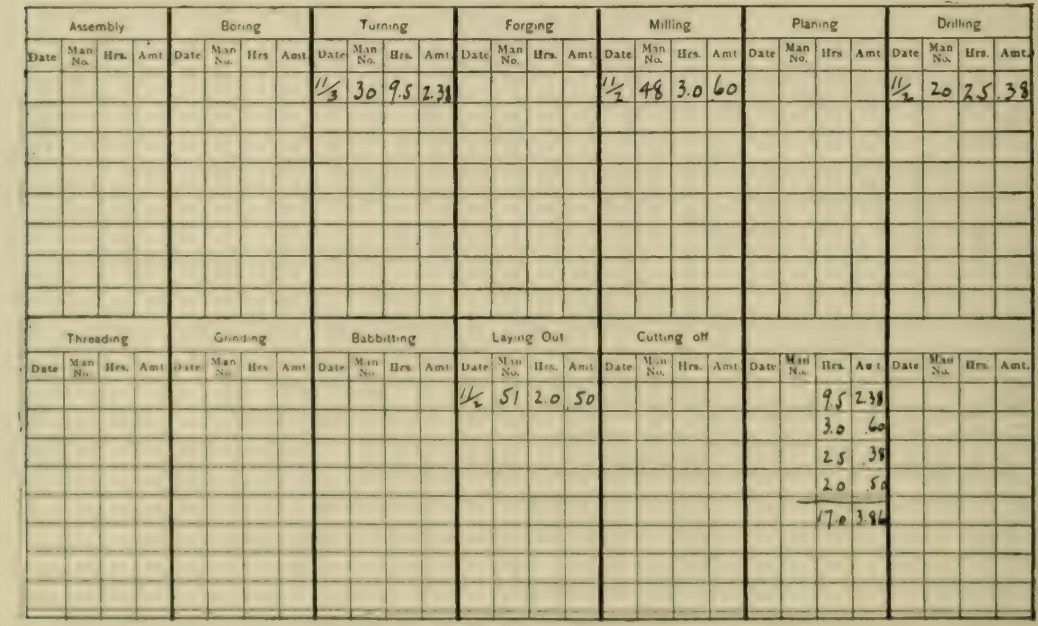
NOTE.—Execute this order, returning same to factory office upon completion of the work. Charge all labor and material to the above Production Order Number.

When this Production Order covers the assembly of a machine, charge "labor" only to the Production Order Number.

W.B.C. Foreman.

FORM B. PRODUCTION ORDER. FACE.

A buff card 8 by 5 inches. Printed on both sides, the back being shown in the cut below.



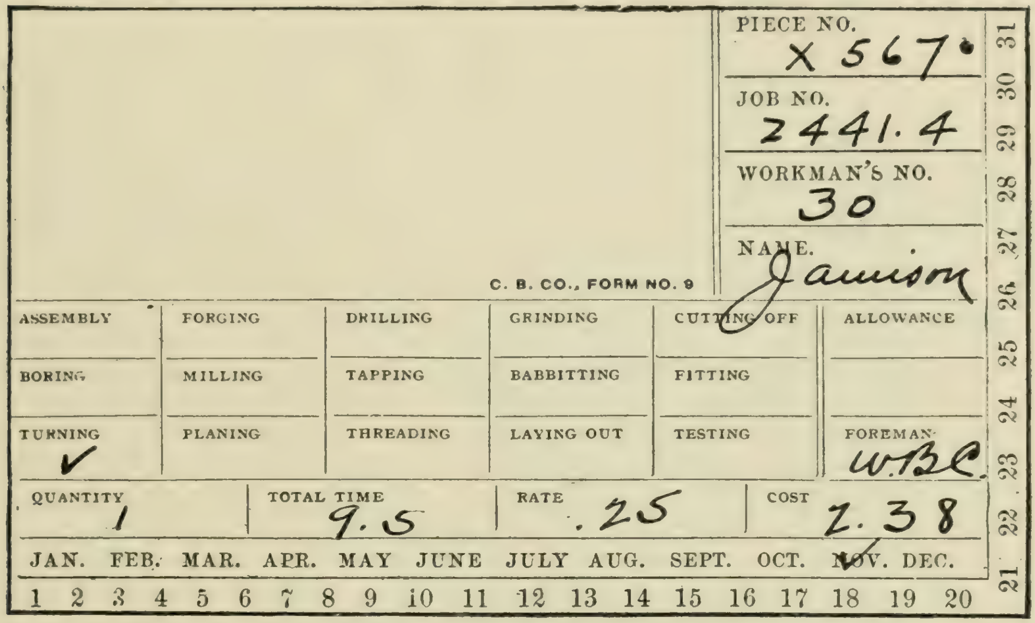
Assembly				Boring				Turning				Forging				Milling				Planing				Drilling			
Date	Man No.	Hrs.	Amt	Date	Man No.	Hrs	Amt	Date	Man No.	Hrs.	Amt	Date	Man No.	Hrs.	Amt	Date	Man No.	Hrs.	Amt	Date	Man No.	Hrs	Amt	Date	Man No.	Hrs.	Amt.
								11/3	30	9.5	2.38					11/2	48	3.0	60					11/2	20	2.5	.38

Threading				Grinding				Babbitting				Laying Out				Cutting off											
Date	Man No.	Hrs.	Amt	Date	Man No.	Hrs	Amt	Date	Man No.	Hrs.	Amt	Date	Man No.	Hrs.	Amt	Date	Man No.	Hrs.	Amt	Date	Man No.	Hrs.	Amt	Date	Man No.	Hrs.	Amt.
												11/2	51	2.0	.50							9.5	2.38				
																						3.0	.60				
																						2.5	.38				
																						2.0	.50				
																						17.0	3.86				

FORM B. PRODUCTION ORDER. BACK.

output at a minimum cost. The office can lend valuable assistance, if the management will go to the necessary expense, by placing in the hands of the shop manager the means whereby minimum costs can be obtained—providing the shop management will not balk, as it often does, at the thought of attempting to use any "office" data to help them in reducing their costs. A proper organization and system—coöperation between shop and office managements—and the result will be a reduction in the costs of production.

Let us say that an order is received from John Smith and Co. for an engine. A "List of Material," Form A, is made out, every item that goes into the building of this engine being listed and given an order and sub-order number, although to illustrate this article only a few of the items have been shown. The shop is furnished with the necessary number of these lists and if it is necessary to machine any of the parts, a Production Order is made out as shown in Form B, which covers the "cylinder head", marked with an asterisk (*) on Form A. This order is made in duplicate, the original going to the department foreman while the duplicate remains on file in the office. The cylinder is drawn from stock on a written requisition and goes to the workmen who are to machine this head. They use Form C, in conjunction with a time clock, for registering the time spent on the various operations, these cards being collected each day, checked against their pay-roll time, sorted by job numbers and posted to the reverse side of the Production Order as shown. When the job is finished, the various operations are totaled and posted to a permanent "Comparative Cost Sheet for Individual Parts"—Form D—the operations—"turning" and "milling" being shown on the line marked with an asterisk (*). The Production Order card can be then thrown away as it has performed its proper functions.



PIECE NO. X 567*

JOB NO. 2441.4

WORKMAN'S NO. 30

NAME. Jamison

C. B. CO., FORM NO. 9

ASSEMBLY	FORGING	DRILLING	GRINDING	CUTTING OFF	ALLOWANCE
BORING	MILLING	TAPPING	BABBITTING	FITTING	
TURNING ✓	PLANING	THREADING	LAYING OUT	TESTING	FOREMAN W.B.C.

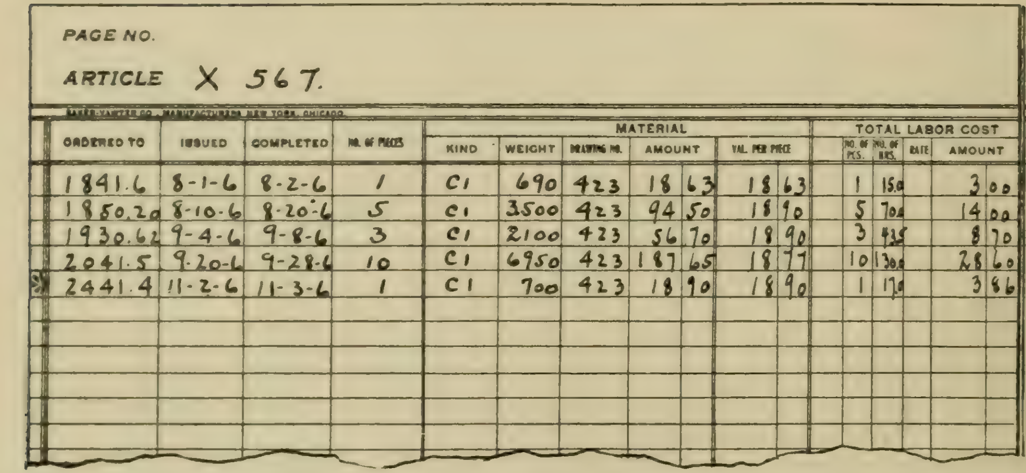
QUANTITY 1	TOTAL TIME 9.5	RATE .25	COST 2.38

JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

FORM C. USED FOR REGISTERING TIME ON OPERATIONS.
Original is a thin buff card 5 by 3 in.

When the engine has been shipped, the cost keeper can take his office list and by going through his book of Comparative Cost Sheets can pick out the weights, hours, costs of materials and labor as shown



PAGE NO.

ARTICLE X 567.

BAKER-VAWTER CO. MANUFACTURERS NEW YORK, CHICAGO

					MATERIAL							TOTAL LABOR COST				
	ORDERED TO	ISSUED	COMPLETED	NO. OF PIECES	KIND	WEIGHT	DRAWING NO.	AMOUNT		VAL. PER PIECE			NO. OF PCS.	NO. OF HRS.	RATE	AMOUNT	
	1841.6	8-1-6	8-2-6	1	C1	690	423	18	63	18	63		1	15.0		3	00
	1850.20	8-10-6	8-20-6	5	C1	3500	423	94	50	18	90		5	70.0		14	00
	1930.62	9-4-6	9-8-6	3	C1	2100	423	56	70	18	90		3	43.5		8	70
	2041.5	9-20-6	9-28-6	10	C1	6950	423	187	65	18	77		10	130.0		28	60
*	2441.4	11-2-6	11-3-6	1	C1	700	423	18	90	18	90		1	17.0		3	86

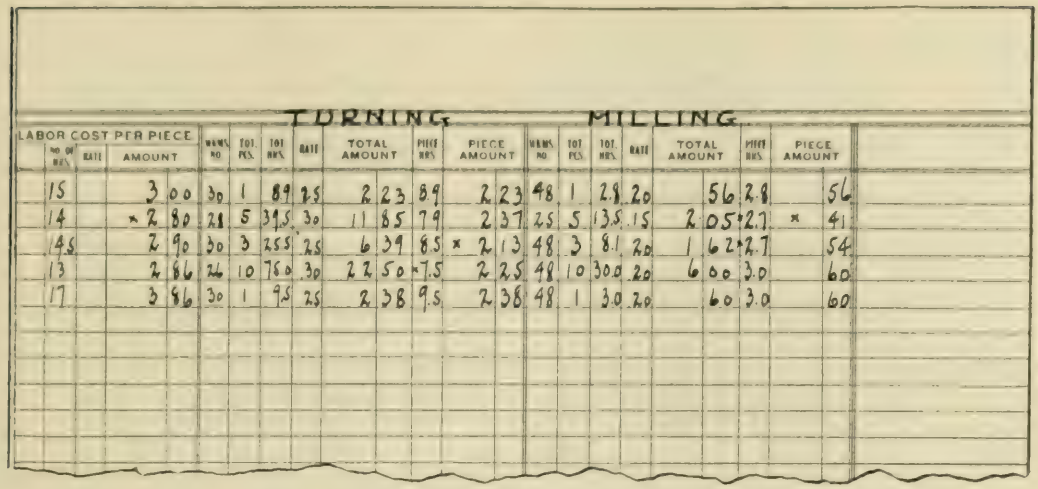
FORM D. COMPARATIVE COST SHEET FOR INDIVIDUAL PARTS. LEFT-HAND HALF. Original is a ruled sheet 16 by 14 in., printed alike on both sides and perforated on one margin for loose-leaf binding.

for the Cylinder Head on Form A. Totaling the various columns and computing the proper burdens on the basis of the productive hours will result in the total cost of the engine, which is posted to the Cost Statement, page 78, as shown. These total costs are then posted to the "Comparative Cost Sheet for Machines and Groups," Form G, page 79, on the line marked with an asterisk (*), so that we now have in black and white everything pertaining to the cost of every operation of every part as well as of the machine itself.

It would seem as if the amount of work necessary to secure and compile all this information is out of proportion to the benefits that might be derived. A perusal of the following, however, will show that the system is not as complex as one would imagine, especially if the possible results are kept in view. Machines are made up of groups, assembled and carried in stock, ready for final assembly with other groups along with perhaps many miscellaneous parts. These groups are in turn made up of parts, which with the miscellaneous parts must be machined, either in lots for stock or according to specification. This involves, in the majority of cases, several operations, so that the "operation" is really the basis—the scale being as follows:

Operations,
Parts,
Groups,
Machines.

If the cost of a complete machine is compared with a previous cost and is found excessive, the management will immediately want to know where the increase is, as well as what caused it; and unless a



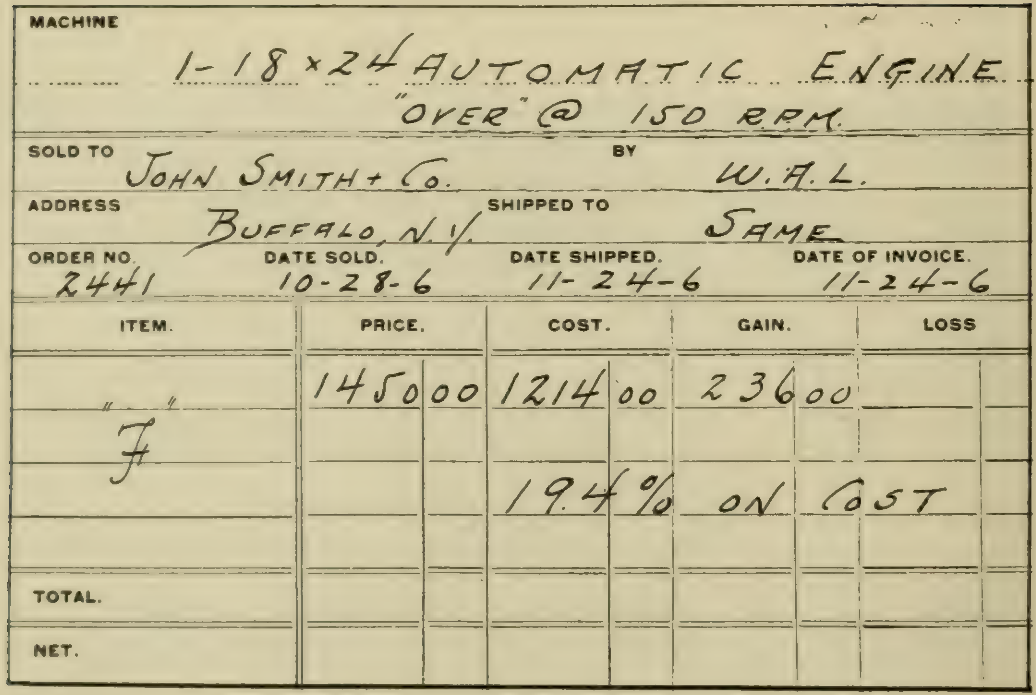
	LABOR COST PER PIECE			TURNING							MILLING							
	NO. OF HRS.	RATE	AMOUNT	WKMS. NO.	TOT. PCS.	TOT. HRS.	RATE	TOTAL AMOUNT	PIECE HRS.	PIECE AMOUNT	WKMS. NO.	TOT. PCS.	TOT. HRS.	RATE	TOTAL AMOUNT	PIECE HRS.	PIECE AMOUNT	
	15		3 00	30	1	8.9	25	2 23	8.9	2 23	48	1	2.8	20	56	2.8	56	
	14		* 2 80	28	5	39.5	30	11 85	7.9	2 37	25	5	13.5	.15	2 05	2.7	* 41	
	14.5		2 90	30	3	25.5	.25	6 39	8.5	* 2 13	48	3	8.1	20	1 62	2.7	54	
	13		2 86	26	10	75.0	.30	22 50	7.5	2 25	48	10	30.0	.20	6 00	3.0	60	
	17		3 86	30	1	9.5	25	2 38	9.5	2 38	48	1	3.0	.20	60	3.0	60	

FORM D, CONTINUED. RIGHT-HAND HALF.

The reproductions as given here show only the general column headings, the mode of ruling, and a number of specimen entries.

proper system has been introduced to take care of just such cases, it will be next to an impossibility to locate the trouble, especially if the machine is made up of a large number of parts, as is often the case. Without definite information the increase cannot be located because of the inability to tell whether groups, parts, or operations caused it. The word "the cost is too high" can be passed from the office to the superintendent, from him to his foremen, and from them to their assistants; but the poor assistants may know as much about what caused this high cost as they do about psychological research, so that no good is really accomplished.

The system as outlined is of value to the management when an excessive cost is located. We will say that the manager, in looking over the cost statement, Form F, finds that he made 19.4 per cent on the cost of this engine; but in looking at his Comparative Cost Sheet, Form G, he is surprised to find that the total cost was $74.50 higher than the cost of the engine previously built. He looks at the weight, the cost of the materials, perhaps at the specifications, and then concludes that the increase is too large to be passed by unnoticed, for he sees that it took the shops 70 hours longer to build this engine than it did the former engine. He takes his List of Material, and by checking back through the book of Comparative Cost Sheets for Individual Parts, Form D, with the cost keeper, he can locate exactly where the increases occurred. It may be that the cost of the bed, wheel and cylinder is in proportion to ones previously built, but when he comes to the cylinder head he notes that it cost in labor $3.86, which is the highest recorded; he finds, in looking across the sheet,



MACHINE
1-18×24 AUTOMATIC ENGINE
"OVER" @ 150 R.P.M.

SOLD TO John Smith + Co. BY W.A.L.

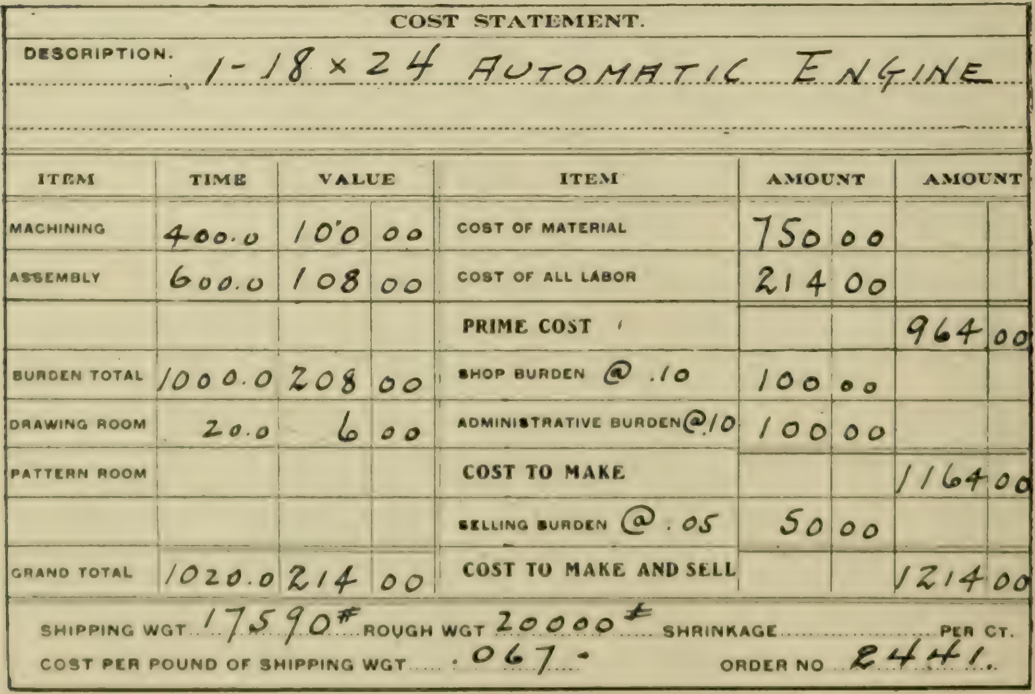
ADDRESS Buffalo, N.Y. SHIPPED TO Same

ORDER NO. 2441 DATE SOLD. 10-28-6 DATE SHIPPED. 11-24-6 DATE OF INVOICE. 11-24-6

ITEM.	PRICE.		COST.		GAIN.		LOSS	
" "	1450	00	1214	00	236	00		
F								
			19.4%		on	Cost		
TOTAL.								
NET.								

FORM F. COST STATEMENT. FACE.

A green card 6 by 4 inches, printed on both sides. The back is shown below.



COST STATEMENT.

DESCRIPTION. 1-18×24 AUTOMATIC ENGINE

ITEM	TIME	VALUE		ITEM	AMOUNT		AMOUNT	
MACHINING	400.0	100	00	COST OF MATERIAL	750	00		
ASSEMBLY	600.0	108	00	COST OF ALL LABOR	214	00		
				PRIME COST			964	00
BURDEN TOTAL	1000.0	208	00	SHOP BURDEN @ .10	100	00		
DRAWING ROOM	20.0	6	00	ADMINISTRATIVE BURDEN @ /10	100	00		
PATTERN ROOM				COST TO MAKE			1164	00
				SELLING BURDEN @ .05	50	00		
GRAND TOTAL	1020.0	214	00	COST TO MAKE AND SELL			1214	00

SHIPPING WGT 17590# ROUGH WGT 20000# SHRINKAGE .... PER CT.

COST PER POUND OF SHIPPING WGT .067 ORDER NO 2441.

FORM F. COST STATEMENT. BACK.

that workman No. 30 took 9.5 hours to turn the head, which for this piece is the longest time that has been turned in. By checking up each part and group the manager can tell with certainty whether the increase is a legitimate one or not, and while one may argue that there

MACHINE 18 × 24 AUT ENGINE.

ORDER	MACHINING HRS	MACHINING AMT	ASSEMBLY HRS	ASSEMBLY AMT	D.R P.S HRS	D.R P.S AMT	TOTAL HRS	TOTAL AMT	SHOP	AD. EX.	SELLING	MATERIAL	TOTAL	WEIGHT	PER #
1600	380	76.00	590	90.00	20	6.50		172.50	97.00	97.00	48.50	760.00	1175.00	17400	.066
1820	375	75.00	520	78.00	12	5.00		158.00	89.50	89.50	44.75	753.00	1134.75	17500	.066
2030	370	74.00	560	84.00	15	5.50		163.50	93.00	93.00	46.50	743.60	1139.50	17450	.066
*2441	400	100.00	600	108.00	20	6.00		214.00	100.00	100.00	50.00	750.00	1214.00	17590	0.67

FORM G. COMPARATIVE COST SHEET FOR MACHINES AND GROUPS.
Headings and rulings only. The original is about 11 in. wide and 9½ high.

is no use crying over spilled milk, I believe that there is such a thing as trying to prevent the recurrence of the accident.

The value of the method outlined, in enabling the management to locate increases and their causes, is not its only advantage; for unless the minor increases are brought to the attention of the shop management the costs cannot be reduced. It is a wise saying—"Look out for the small things and the larger things will take care of themselves," and it applies to costing as no other saying could. One of the most important parts of the system outlined is the bringing, automatically, to the attention of the shop foremen any increase in the costs of operations. The clerk in entering the order 2441.4 on his cost sheet (Form D, page 77), noticed that the turning took more time than on the record order—time being considered the basis. He accordingly made out a "Comparative Cost Report," Form H, as shown on page 81, sending it to the foreman, who investigated and found that No. 30 was at fault. In investigating, he necessarily spoke to the workman about the increase shown. Can anyone imagine that the words spoken to this man were in vain? Intelligent workmen desire to retain their positions and will be anxious to try and wipe out any increases. If, however, they do not care—and there are some workmen of this stamp—these little Comparative Cost Reports will weed them out in time.

Any system that will enable the shop manager to pass upon the efficiency of his men is a system that he as well as the management should welcome, as it embodies one of the essentials of cost reduction. Reference to Form D will show that No. 30, rate 25 cents per hour, has turned five cylinder heads X567 in lots of one, three, and one, the time for each one being 8.9, 8.5 and 9.5 hours respectively, while it will be noticed that two men at 30 cents an hour took this same job and turned the head in 7.9 and 7.5 hours, which is quite a reduction in time. It is true that the cost of one piece in lots of ten is less than the cost of one in lots of two or three, but it does not seem as if there should be an increase of two hours on the turning of job No. 2441.4 over No. 2041.5. At any rate, the record is clear enough to show the foreman that workman No. 30 should be spoken to, and that No. 26 is the man to put on work of this nature; for although the "piece amount" does not show a large reduction, the total cost has been reduced quite a little by this higher priced man as follows—

Job	Labor	Time	Burden
No. 2441.4	$2.38	9.5	2.38
No. 2041.5	2.25	7.5	1.88
Gain,	.13	2.0	.50

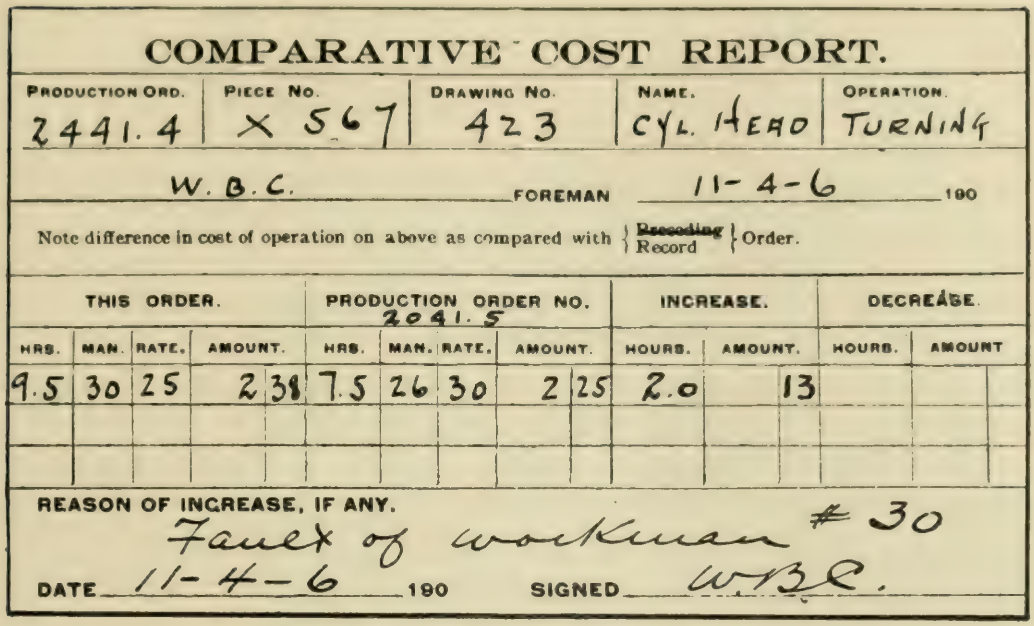
Total gain—63 cents, plus the two hours time.

I figure burden here on the productive hours as a basis, which is far more accurate than to use the productive value, inasmuch as a 25-cents per hour man uses as much of the power, heat, light, etc., as does a 10-cents per hour man.

A glance at the milling operation (Form D) will show that while No. 48, a 20-cents per hour man, did this work in about the same time for each piece, No. 25, a 15-cents per hour man, milled the work in 2.7 hours each on a lot of five as against 3.0 hours by No. 48 on a lot of ten, which shows that while No. 25 is a cheaper man, he is one that will stand coaching and right treatment.

Another point to consider is the value of the Comparative Cost Sheet—Form D—when new men are engaged, for the reason that in giving these new men work to do, the foreman can at the same time tell them the time it has taken to turn out the work in the past, and if a record is kept of the work of new men for a short time and compared with that turned out by former workmen, their efficiency or inefficiency can soon be determined.

A large number of concerns have under consideration the introduction of piece, premium, and other systems; and while it is not



COMPARATIVE COST REPORT.

PRODUCTION ORD.	PIECE NO.	DRAWING NO.	NAME.	OPERATION.
2441.4	X 567	423	CYL. HEAD	TURNING

W. B. C. FOREMAN 11-4-6 190

Note difference in cost of operation on above as compared with { ~~Preceding~~ Record } Order.

THIS ORDER.				PRODUCTION ORDER NO. 2041.5				INCREASE.		DECREASE.	
HRS.	MAN.	RATE.	AMOUNT.	HRS.	MAN.	RATE.	AMOUNT.	HOURS.	AMOUNT.	HOURS.	AMOUNT
9.5	30	25	2 38	7.5	26	30	2 25	2.0	13		

REASON OF INCREASE, IF ANY.
Fault of workman # 30

DATE 11-4-6 190 SIGNED W.B.C.

FORM E. COMPARATIVE COST REPORT.
Original is on white paper, 3 by 5 inches.

absolutely essential, it would be beneficial if some data were available which would give the time and costs of parts and operations. If the system described had been in operation any length of time and it was desired to install a premium system, it would be no difficult matter to select a few pieces at any time and by going through the cost book set "time limits" which would be more satisfactory to the management than approximations as to the time in which a piece should be completed; the effect on the workmen also would be about all that could be expected, for they could be made to realize that the time limits had been based upon past performances, and the better class of men would be satisfied in their own minds at least that it would be unfair to ask the company to set a limit on a piece or operation lower than the results obtained in the past.

It might be argued that in a large number of cases the costs could not be decreased to any appreciable extent, so that a system as outlined would be unnecessary. I will grant the first part of the argument, but not the second part; for we will suppose that a machine which we will call "X" costs $1,000 and sells for $1,200, while a competitor sells a machine patterned along exactly the same lines for $1,100. The manager has decided that his facilities for turning out the machine in question are as good as those of his competitor, so calls the shop management into consultation. If there were no detailed costs it would be impossible to know where to begin the investigation, so that the result of the consultation would be productive of little good.

But let us suppose that a system along the lines outlined has been in operation some little time. The List of Material is taken and each item checked with the Comparative Cost Book, and after a careful discussion it is decided that a reduction in the labor costs cannot be expected. It does not follow that this knowledge renders a reduction in the cost out of the question, for a study of the design of each part with the end in view of reducing the weights might be productive of some good. If, however, it is found that the weight of the machine cannot be lessened without impairing its efficiency, the question of better tools, improved jigs, and perhaps more efficient equipment could then be considered. Even if the investigation did not bring about the desired results—though it is very likely that it would—is there anyone who would argue that the investigation would not elicit information and suggestions from those interested, concerning labor costs of parts and operations, the design and weight of the parts, the question of better tools and jigs, which would be instrumental in reducing costs along other lines?

It may be well to explain that the time necessary to secure and compile the information pertaining to the product is not as great as one would suppose, especially if the system has been carefully devised to meet the existing conditions and the clerks each day record all the data secured the previous day. The main requirements are a harmonious organization—all working for the best interests of the company—and a time-keeping system that can be depended upon. If these are to be had, the cost of the securing, recording, compiling and investigating the data will be more than offset by an increase in the production in the same number of productive hours, which means—"Cost Reduction."

PRESENT PRACTICE IN THE USE OF SUPERHEATED STEAM.

By Reginald Pelham Bolton.

II.

In a preceding article Mr. Bolton reviewed the early troubles experienced in the use of superheat, the most important recent tests and experiments (American and Continental), and the general relations of superheating to economy in the steam cylinder. A concluding paper will take up locomotive and marine practice and will present also a bibliography of the literature of the subject.—The Editors.

IT is a not infrequent matter of comment by enthusiastic European advocates of high-temperature superheat, that general American engineering opinion seems to have settled into a position adverse to their view.

They point, and with justice, to the remarkable results achieved by the use of superheat of from 400 degrees to 700 degrees F., so well recognized in Europe that manufacturers of engines specially designed to operate with those high temperatures feel safe in guaranteeing effective results of an extraordinarily economic character. Steam engines of various classes are readily procurable under guarantees of operation affording an effective horse power for the following steam consumption, with added heat of 500 degrees to 600 degrees:

Single Non-Condensing,	15.5 lb.
Single-Cylinder Condensing,	13 lb.
Compound Condensing,	10 lb.
Triple Condensing,	8.75 lb.

while American manufacturers are declining to contemplate the construction of machines for such high temperatures. There is, however, much to be said in favor of this point of view, which is by no means wholly American.

The prime cost of such high-class machines, their special character and comparative delicacy of mechanism, are features which may, and, no doubt, do discount by fixed charges, for interest, depreciation, repairs, and high-class labor, much of the refinement of economy resulting from their use, I prefer, however, to regard the reluctance of American manufacturers in this direction as being based on the very practical view, that the generation of such high temperatures in the superheater is liable to difficulties and objections in operation due to the necessarily accompanying high temperature of gases, and to the considerable fluctuations liable to be met with; and it is certain in the present state of the art of the addition of superheat to steam, that much remains to be learned and accomplished in these directions.

A trial by M. Marechal of Rouen showed that an economy *in fuel* established by superheat at 536 degrees F. was not increased or bettered, in the same engine and boiler combination, by an increase to 650 degrees F.

At the Annual Congress of the Associations of Steam Apparatus Manufacturers in 1894, Marechal gave an economy of 16.5 per cent in *coal* for a saving of 22.3 per cent in steam, with steam superheated 536 degrees F. Later, Marechal tried again at 650 degrees F. and found he did not reduce the coal. But the engine may have responded and probably did respond to the increase in superheat, as shown in the successive trials of steam turbines reported by Hodgkinson, but it was the flue-gas and superheater combination which was at its limit of economy at the lower figure.

M. Dejace of Brussels gave an economy of 6.2 per cent in *coal* for a saving of 16.4 per cent in steam, with steam superheated 473 degrees F.

Such effects may be due not only to flue-gas conditions, but to the fluctuating extent of added-heat; and in both we may feel that a proper conservatism has awaited development which shall place the superheater in a more definitely desirable and controllable condition. That these conservative considerations are not confined to American engineers is evident by a perusal of the opinions of some of the eminent French and German engineers who have specially studied the subject. Vanderstegen admits that:

> "It cannot be said in a general manner, that superheat is always to be applied, or at what temperature, or that it should be systematically prescribed.
>
> "In large installations, such as central stations, where the special object is the reduction to a minimum of the cost of the kilowatt, superheat is demanded.
>
> "On the contrary, when the machine is of small importance, or where its work is very variable, or where it operates in an irregular manner, and above all, if the operating staff has not the necessary competence, it is evident that very often the economy to be secured may not outweigh the complication of the installation."

M. Ch. Compère, whose valuable summarization of experiments and data for the Société des Ingenieurs Civils has been already referred to, concludes his observations with the remark that, "with well-considered applications, superheat will enable the steam engine to compete with the gas engine, but it must not be overlooked that the addition of superheating apparatus adds a complication to the installation"; and he, therefore, insists upon "the necessity of studying each installation in all its parts, boiler, engine, superheating, and piping."

A practicable limitation of the desirable extent of superheat has been found to exist in the temperature of the exhaust. Experiments on existing conditions of turbine and condenser, in which the heat conditions have been varied by an addition of heat to the steam supply, have shown remarkable results in gain of economy, due to the fact that, by reduction of cylinder losses, the total weight of steam was largely reduced; and the total heat, therefore, emitted to the condenser became less than that with which its proportions and the extent of its cooling medium were designed to deal; consequently, it produced superior results in the reduction of pressure and showed large accessions by "increased vacuum."

But such relative gains must not be taken to afford a measure of the value of superheat or they will lead to disappointment. A due proportion between added heat, cylinder conditions, and condenser proportions, is the combination to which the designer of such machinery is necessarily led, and here again the value of the subject of superheat is demonstrated, in directing the attention of engine designers and machinery owners to the consideration of condenser details and conditions, an element in the combination of power production commonly treated with almost as much disrespect and callousness as that of fuel.

In this respect then, we may also feel that a step has been made, a distance marked off, and a fresh incentive indicated, by the past ten years; and it may be added that while much of the work in this direction is due to English marine practice, American engineers, in the development of power-station practice, have taken no inconspicuous part.

HEATING BUILDINGS.

As a heating engineer, I could not pass from this subject without touching upon its bearing on the matter of interior heating, which, on account of climatic conditions, so vitally affects American steam-engine practice. Questions have been put to me on increasingly numerous occasions during recent years, as to what benefit can be expected from the combination of superheat in steam apparatus, the major use of which is to operate—as reducing valves—for the supply of exhausted steam into heating systems. There are many cases, for instance, where the supply of exhausted steam is not sufficient for the work of heating, and common practice, then, introduces into the system a supplemental supply of live steam, reduced in pressure through a reducing valve, and by this process, of course, more or less superheated. Practical operation, confirming the known theory of the subject, has shown that such superheated supply does less effective work in heat-radiation than the saturated exhaust, and it has frequently involved a loss of economy in results. How, then, shall a steam supply still further initially heated afford satisfactory results? The subject is one involving consideration of each separate set of conditions, but, broadly speaking, there appear to be the following directions in which advantage may exist, provided the combined apparatus be harmoniously designed and proportioned.

An addition of superheat is of advantage, if carried so far as the point at which radiation is desired but no further, at which point saturation should be designed to supervene.

Advantage may then result from the absence of moisture in mains and branch piping. Supply pipes for high-pressure superheated-steam supply may be of smaller size than those for saturated steam, the accepted sizes of which have been affected by the presence and propulsion of moisture.

But I can see no reason why heating practice should lag behind the development of steam-power production. While existing heating appliances have all been developed from practice with the use of fully saturated vapor, it seems not unreasonable to expect that the wider demand for the use of superheated steam, due to economies effected by its use prior to its exhaust into the heating systems, will force upon designers of the latter apparatus modifications which will advantageously utilize vapors at higher temperature and in dry condition. Such improvement would appear to lie in the direction of a great reduction of annular or interior spaces in radiating apparatus, the interposition of a less depth of vapor between the surfaces of dissipation of heat, and also of the production of a more active circulation of the heating vapor over the dissipating surfaces.

If this course be followed, the next few years should see American steam and heating practices fully in accord. The importance of the latter part of engineering work in the United States is undeniable, inasmuch as American practice, systems, and appliances for heating are now generally accepted by the rest of the engineering world.

STEAM PIPING.

The introduction of superheat into existing piping, planned and proportioned to provide for saturated steam, introduces a considerable risk on account of the increased degree of expansion. Such piping, also, will be found to be undesirably large, and may thus in part defeat the object of the added heat. Since the rate of travel of the ad-heated gas should, as practice has generally demonstrated, be greater than practice has established for low-temperature steam, speeds up to as high a rate as 20,000 feet per minute may be found practically economical, the loss in pressure due to such rate being compensated for by the conservation of superheat. The commonly accepted proportions and arrangement of pipes must, therefore, be considered as subject to considerable modification in future, and yet the precautions of standard methods in providing for drainage of pipe runs are quite as necessary, since the high velocities introduced are liable to produce peculiarly severe water hammer if any condensation should be present in opening up a pipe to the supply.

The growing tendency to adopt high working pressures has already brought out a supply of methods of jointing, materials for packing, improved forms of pipe anchorages, and expansion joints, which are adapted to the purposes of high temperatures. Much more care will be necessary in the selection of materials and in the design of piping and accessories.

George Hutchinson, in Transactions American Society Mechanical Engineers, Vol. XXIV, points out that if superheated steam be introduced into a pipe system designed for saturated steam, there will be a diminished difference of pressure between the two ends of the line on account of the lower density of the superheated vapor and its freedom from moisture; and the same conditions will also cause a reduction in friction.

In large pipes, of course, the beneficial effect is increased by reduction of radiation, and with small pipes, the gain is chiefly produced by reduction of throttling. In the latter case, a speed of 100 feet per second with superheated steam will correspond approximately to the friction, or throttling loss, of saturated steam at 60 feet per second. The combination of high speed and extra covering is to be aimed at in proportioning any piping for superheated vapor; under best circumstances, the loss by friction may be no greater than with saturated vapor, and the radiating loss equivalent to a degree F. for each 6 feet of pipe.

Joints.

The introduction of such high temperatures in piping has caused much difficulty on account of the failure of joints, packing, and expansion arrangements. The trend of up-to-date work in this line is towards the use of extra heavy piping, flanged joints of specially secure character, metallic packing or jointing material, and provision for expansion by the spring of bent or curved tubing.

Forged flanges are now made in standard sizes, and are connected to the pipe in a number of ways, by shrinking, rolling, threading, or by "peaning" the end of the pipe over the flange. The face, in all high-class work, whether of the flange or of the "peaned" tube, is turned, making a true face for contact with the metallic gasket. Spring bends are also made in standard forms and sizes, the capability of extension and contraction of which is ascertainable.

Pipe covering must be more complete and, therefore, more expensive. An example reported by Prof. Jacobus at Melbourne Mills, Minnesota, may be quoted: a pipe of 6 inches diameter carried a covering of an outside diameter of 12½ inches; the covering was composed of 1⅛-inch asbestos felt, and outside of this covering was a layer of carbonate of magnesia, held by wire, and plastered over with asbestos cement.

WATER-WORKS ENGINES.

This class of engine has been developed to an extremely high degree of efficiency and excellence, and in it, therefore, the advantage to be gained by the addition of superheat is relatively the least, and comparatively small increase in economy is to be anticipated. Pumping engines showing mechanical efficiency as high as 96 per cent are in operation, in which refinements in construction and in re-heater and feed-water heater combinations, have resulted in duties as high as 178 million foot-pounds per 1,000 pounds of coal burned, steam consumption as low as 10.32 pounds per indicated horse-power hour, and a coal consumption of 1 pound per indicated horse-power hour. Nevertheless the addition of superheat is capable of producing some benefit even in such extraordinarily economical combinations, as will be seen from the following example. The results show a progressive increase in duty following progressive increase in superheat. Practically similar conditions of vacuum and of pumping head were observed.

Tests of Worthington High-Duty Pumping Engines, at the Central Park Station, Chicago.

Reported in the Engineering News, of May, 26, 1904.

Steam Pressure	141	142	147	145	144
Superheat, F.,	63.4	71.2	87.2	142	154
Duty per 1,000 lb. steam	156,602,731	157,133,021	161,676,942	163,104,857	174,735,801

Relation to Coal Consumption.

Fuel.	Maryland and Juniper.	Pocahontas.	Maryland.	Maryland.	Maryland.
Calorific value,	13,500	14,260	14,191	13,531	14,213
Duty per 100 lb. Coal,	137,502,733	150,592,270	149,067,802	132,607,122	150,971,958

These results show that the fine performance of the engine had been to a great degree neutralized at the furnace.

The No. 10 pumping engine in the St. Louis water works reached a duty, with dry saturated steam, and only 126-pounds pressure, of 179,454,250 foot-pounds per 1,000 pounds of steam, and it will be seen, therefore, that very close study and careful arrangements will be needed to improve the work of such wonderful machines by mere addition of heat to their working supply.

TURBINES.

In the development of the turbine during the past decade, superheated steam has played a most important part. The feature pointed out by Professor Thurston, in his last paper before the American Society of Mechanical Engineers, namely, the peculiarly undesirable effects at turbine speeds and under turbine conditions, of the presence of moisture in steam, has been conclusively demonstrated and has led to the settled conjunction of superheat with turbine operation.

Numerous demonstrations have been made of the beneficial effect of superheat in such apparatus, which are really demonstrations of the injurious effect of the presence of moisture. The resultant economy has been shown to be practically constant under considerable variations of load. A series of tests on the Parsons type, reported by Mr. Francis Hodgkinson in 1904, demonstrated the foregoing so very clearly as to be worth re-presentation.

Speed of 1,800 revolutions per minute, Same machine throughout.

A. Non-Condensing.

Pressure.	Load.	Lb. of steam per Brake Horse power hour.
Without Superheat.		
140 lb.	99 per cent.	28.26
With Superheat, 100° Fahr.		
155.5 lb.	36 per cent.	30.33
153.5 lb.	70 per cent.	24.06
149.4 lb.	142 per cent.	23.46
B. Condensing, 28 inch Vacuum.		
Without Superheat.		
151.9 lb.	19 per cent.	19.89
151 lb.	52 per cent.	15.52
149.8 lb.	74 per cent.	14.49
149.5 lb	102 per cent.	13.77

With Superheat, 100 degrees F.

Pressure.	Load.	Lb. of steam per brake horse power hour.
154.7 lb.	32 per cent.	15.32
150.8 lb.	65 per cent.	13.27
151.4 lb.	103 per cent.	12.38
150.9 lb.	143 per cent.	12.99
150.1 lb.	198 per cent.	13.91

Another test, or rather series of tests, on a 1,000 horse-power turbine, with 150-pounds pressure, 1,800 revolutions, gave:

Non-Condensing. Full load.

Saturated Steam	28.1 lb. per brake horse power hour.
Superheat, 100 degrees F.	23 lb. per brake horse power hour.

Condensing. 28 inch Vacuum.

Saturated steam,	14 lb. per brake horse power hour.
Super-heat, 100 degree F.	12.4 lb. per brake horse power hour.

Other tests on machines of similar proportions gave, with different degrees of vacuum:

Saturated Steam. 26 inches Vacuum, 1,800 revolutions.

Pressure.	Load.	Lb. of steam per brake horse power hour.
155 lb.	48 per cent.	18.35
154 lb.	71 per cent.	16.62
152 lb.	103 per cent.	15.06
152.5 lb.	141 per cent.	14.7

Superheat, 150 degrees F. 26 inches Vacuum. 1,800 Revolutions.

Pressure.	Load.	Lb. of steam per brake horse power hour.
152.5 lb.	48 per cent.	16.
150.7 lb.	92 per cent.	13.18
148.7 lb.	118 per cent.	13.
145 lb.	141 per cent.	12.98

Saturated steam. 28 inches Vacuum. 1,800 revolutions.

155 lb.	48 per cent.	15.95
151.5 lb.	72 per cent.	14.65
151.5 lb.	102 per cent.	13.76
152 lb.	143 per cent.	13.99

Superheat, 150 degrees F. 28 inches Vacuum. 1.800 revolutions.

151.4 lb.	48 per cent.	13.85
148.6 lb.	98 per cent.	11.79
149.9 lb.	124 per cent.	11.42
149.2 lb.	141 per cent.	11.5

Trans. Am. Soc. C. E., Vol. LIV., 1904.

A test on Curtis turbines, reported in Transactions of the Engineers Club, Philadelphia, 1904, gave these results:

Kilowatts.			Steam per indicated horse power hour
600	140 lb.	saturated steam	12.2 lb.
600	140 lb.	superheat, 150 degrees, F.	10.68 lb.
2,000	156 lb.	superheat, 212 degrees, F.	9.76 lb.

We may conclude therefore that under all conditions of operation, whether condensing or non-condensing, and under extreme divergences of load, the addition of heat to the steam in the turbine engine has demonstrated its desirability, and may be taken as an element of standard practice which will keep pace with the development of steam-turbine installations. Inversely, it is to a great extent true that the turbine owes its advance in favor to the settled character of this feature of its installation.

RARE METALS AND MINERALS AND THEIR USES.

By E. Schaaf-Regelman.

The development of special alloy steels and extensive investigations on metallic filament incandescent lamps have produced, within the past few years, a considerable demand for the rarer metals. The details of the economic applications of these materials are a matter of common knowledge, but little is generally known of the minerals and sources from which the metal supply is drawn. Mr. Schaaf-Regelman's paper presents interesting information on these questions, of which his position as a specialist in rare metals and minerals gives him an authoritative knowledge.—The Editors.

IT is not more than a few years since the so-called "rare minerals" first attracted attention outside of the scientific world, but within a very short period this branch of the mining industry has become of such importance to many metallurgical and chemical industries that a study of the great progress made in this line and the conditions of supply and demand is very timely.

The strongest impetus for the search of many of the ores containing rare metals has come from the steel industry and its allied metallurgical branches, and the alloying of steel with other metals is, in the opinion of many, the most conspicuous proof of the ardent desire of our engineers for progress and improvement. In the oldest times tools and weapons were made of stone, later on of copper, brass and other metals and alloys, which we consider soft today; finally iron was used, and our fathers and grandfathers converted this into steel; but even the best qualities of steel are inadequate for our modern working methods, and especially our high-speed tool-machines require a more resisting and durable material for their cutting, milling, fraising, planing and boring tools than the best tempered steel will enable us to produce.

Manganese, nickel, and chrome alloys of steel are those used most extensively, but less for tools than for other purposes, and these metals cannot be classified as rare and are therefore not considered here.

Tungsten, or Wolfram, as it is sometimes called, although unknown to many a man, is on the verge of turning from a rare into a common metal, as its regular production on a large scale is now an assured fact. While the whole world's production of tungsten-ore concentrates during the year 1900 amounted to only about 150 tons, of which the United States furnished about 40 tons, there were 3,500 tons produced during the year 1905, with about half of this quantity coming from Australia, about 820 tons to the credit of the United States, and the rest from several European localities, each of but little importance. At least 80 per cent of the American production come from the State of Colorado, and as the deposits in that State are extensive and easily accessible, the output could at least have been doubled during recent years, had it not been that competing interests were fighting for the supremacy in this field. A large proportion of the American production has therefore been exported and sold to European consumers, while several American makers of tungsten compounds were obliged to buy Australian ores in order to keep their works going and to supply the constantly increasing domestic demand.

The chief use of tungsten is in the manufacture of tungsten steel, and this again is mostly used for high-speed tools, magnet steels, and in European countries also for armor plates and projectiles. The percentage of tungsten in tool steels varies greatly, according to the special use for which they are intended, but tungsten always imparts to the steel the property of self-hardening in the air after forging without necessitating any of the usual methods of tempering.

It is unquestionable that the United States leads in the manufacture of tool machinery, and consequently the demand for tungsten steel is so large that considerable quantities of ferro-tungsten and tungsten metal have to be imported; but it is gratifying to an American to note the decrease of these imports and the increase of domestic manufacture and, as strong and intelligent interests have taken hold of the situation in Colorado recently, it is to be hoped that the mining end of the business also will henceforth be developed more satisfactorily and make American manufacturers independent of the vagaries of a very erratic ore market.

MOLYBDENUM, which, in spite of the widespread attention it has received of late, still preserves all the characteristics of a rare metal and will undoubtedly remain "rare" for some time to come, is largely used for the same purposes as tungsten; but in addition thereto it enjoys many and varied applications in the chemical and ceramic industries, but the quantities used in others than the metallurgical line are but small. Although it is authoritatively stated that the action of molybdenum in the steel is from two to three times as powerful as that of tungsten, technical difficulties have opposed themselves to the production of pure compounds at low costs; but as soon as a constant and reliable supply of the raw material shall be insured, these difficulties will certainly be overcome. Molybdenum will then have a much wider range of application, inasmuch as it is already now used advantageously for improving the steel for rifle barrels, for large guns, for propeller-shaft forgings, and also for wire drawing, as, if a certain proportion is added to the steel, this increases its elongation considerably and improves its flexibility. Moreover, the manufacture of molybdenum steel is less complicated than that of tungsten steel, and as soon as a regular production of molybdenum ores can be relied upon this metal will become of very great importance.

Australia is again the chief producer of the ores containing molybdenum, and last year's output is estimated at about 70 tons While the American continent, especially the eastern part of Canada, produced nearly the same tonnage, this ore is of much lower percentage and consequntly of smaller yield, but Canadians are slow to adopt modern machinery and improved methods for the treatment of these ores, while Colorado will within a short time have a plant especially designed for concentrating them and it is very likely that this State will soon outclass Canada, as the ore bodies are plentiful but of no commercial value without the proper treatment.

VANADIUM and URANIUM are nearly always named together as almost all ores containing one metal also contain the other. Uranium, however, is used very little for steel-hardening purposes outside of the well-known German steel foundry and gun factory of Krupp at Essen, where the use of uranium has apparently passed out of the experimental stage but where the knowledge of its application is guarded most jealously. Vanadium, on the other hand, has been used in France and Sweden for many years for increasing the tensile strength and toughness of steel, but its high price has prohibited its application on a large scale. The French and German armor-plate works use an alloy of vanadium and nickel and obtain excellent results and the superiority of French automobiles is said to be due to the liberal application of vanadium steel in their construction. Although vanadium alloys have been offered in the United States extensively for quite some time it has not been possible to awaken a general interest among American steel manufacturers, but developments are watched eagerly now as one firm has recently started the treatment of the Colorado vanadium ores on a comparatively large scale, and ferro-vanadium is to be manufactured in the Pittsburg district and marketed at a lower price than the imported material has been offered at so far.

Uranium has been detected in more than a dozen different minerals, which are found in nearly all mountainous countries of the globe, but the percentage of the uranium is generally too small to warrant extraction, and workable deposits of uranium minerals are limited. Since the discovery of radium these uranium minerals have become of special interest, as the percentage of uranium is in direct proportion to the radio-activity of the mineral, and all other applications of uranium metal and uranium salts, which latter are used to some extent as color on porcelain and glass, are overshadowed by the importance of uranium as the chief source of radium.

TITANIUM is unique among the metals used for steel alloying purposes, as the raw material, i. e., ore containing titanium, is most abundant; but the metal and its alloys are distinctly rare, and while it is known that titanium imparts to the steel most valuable properties, its application is still in its infancy, because the technical difficulties in an economic production on a large scale have not been overcome as yet.

An ore called Rutile with a high percentage of titanium is mined in the southern States, but its principal use is as a pigment in the ceramic industry, as it has been found difficult to alloy high-grade titanium material with steel in the ordinary way. The perfection of the electric furnace has been a marked progress, however, and the great amount of experimental work now being done in this direction aims at the utilization of the vast ore bodies of titaniferous iron ores found on both Western and Eastern Continents, and the production of steel with varying contents of titanium directly from the ore. The principal advantage of the presence of titanium in steel is that it increases the density of the material and particularly its transverse strength, thus giving a harder chill and better wearing quality. It is claimed, therefore, that titanium steel will be the coming material for car wheels and axles and its application to rolling and crushing machinery will also be very extensive.

It is noteworthy that the best results are obtained in many cases by alloying not only one of the above named rare metals with steel, but by compounding them with nickel or chromium, and tungsten-chromium-steel, tungsten-nickel-steel, molybdenum-chromium-steel, and other similar combinations are the result. They have many distinct features different from an alloy of one of these metals with steel. Variations in the proportion of each constituent very often produce surprising effects, and metallurgical and chemical engineers have a wide and varied field of investigation and research before them.

Even so short a treatise on the subject as the present one should not fail to mention the pioneer work done by the alumino-thermic process in the manufacture of rare metals of exceptional purity, but their high price has materially restricted their application.

Europe has so far led in the manufacture of these metals and alloys, and large quantities of ores, carrying such metals, have been exported from America to Germany, France, and England and the finished metals and alloys have been re-imported. While there are in the United States a small number of plants devoted to the manufacture of these special alloys, their output is far too small to satisfy the rapidly increasing demand, and the main drawback to an adequate growth of this industry has been the lack of thoroughly trained chemists and metallurgists. With her gigantic steel industry, her unrivaled machinery manufacture, her abundant supply of raw materials, and the strong desire for higher efficiency in every branch of her industrial life, it is high time America should utilize at home her natural resources, aided by particularly favorable conditions. The study of this branch of metallurgy seems to offer splendid chances to many an American youth with a technical turn of mind, as the field is but little exploited as yet and promises a great future.

These rare metals, or better their salts, are also used in the chemical and color industry and, while there is a great variety in their application, their importance in these lines will always remain secondary to that as steel hardeners.

TANTALUM. Another rare metal, which has attracted universal attention during the last two years, while before it was scarcely known outside of some scientific laboratories, is tantalum. It was first discovered and investigated in 1802 by a Swedish chemist, named Ekelberg, who, on account of the tantalizing difficulties experienced in extracting the metal from its ores, called it "tantalum," deriving this name from the ill-fated king Tantalus, well known to students of Greek mythology. Only two years ago was it found out by German scientists that what the discoverer thought to be tantalum was an alloy of it and a carbide, and more tantalizing efforts were necessary to produce this metal in its perfectly pure state; but this success once being reached, the metal immediately became of such an importance that it is now revolutionizing at least one large industry, that of the manufacture of incandescent lamps for electric lights. The German chemists, experimenting with this unique metal, were connected with the well-known firm of Siemens & Halske, of Berlin, manufacturers of electrical machinery and apparatus, and they thought this evolution of such importance that they protected their process of extraction and utilization of the metal by more than two hundred patents in all civilized countries.

The so-called tantalum lamp is an incandescent electric lamp with a filament made of a very fine tantalum wire instead of a carbon filament as in the ordinary incandescent bulbs. The most salient features of the tantalum lamp are that, while the filament is so arranged as to have a total length of about two feet, without materially increasing the size of the lamp, but half of the amount of current is needed to produce a light of the same intensity as that of an ordinary lamp with a carbon filament, and the light is so much brighter and whiter and the life of each lamp is at the same time increased so considerably that, in view of all these advantages, it would be more economical to pay one dollar for a tantalum lamp than to get the old carbon lamps for nothing.

It is most remarkable and without precedent in the history of any rare metal, how quickly the supply has responded to the demand. Prior to this invention the whole world's production of tantalum-bearing minerals was too small even to supply all museums and mineral collections with good specimens; now Australia alone has produced more than seventy tons of tantalite, the most important of these minerals, during the last year, and Norway, Sweden, France, Finland, Southern Russia and the United States have also produced appreciable quantities of tantalum-bearing minerals. In America these have mostly the form of columbite, a complex mineral with varying percentages of tantalum, niobium, iron and manganese. Considering the fact that one pound of tantalum metal is sufficient for 23,000 lamps of 25 candle power each, it is easily understood why there is already an overproduction of tantalum-bearing minerals, the price of which has consequently decreased so materially that only a pure and high-grade mineral is saleable today. There is no doubt, however, that these conditions will change as soon as other uses of tantalum are beyond the experimental stage. Although it has been tried to use tantalum as a steel-hardening agent, the mechanical difficulties in alloying tantalum with steel have been so great that we shall probably see other applications come into prominence first. Tantalum is one of the hardest substances known and its use for scientific instruments, where price stands always second to accuracy and durability, will doubtless be developed much sooner, inasmuch as tantalum also resists the corrosive influence of acids and alkaline solutions in a very remarkable degree.

One of the most striking experiments to demonstrate the hardness of tantalum was, that for the purpose of boring a hole through a sheet of pure tantalum metal, a diamond drill-bore was used, revolving incessantly for three days and making 5,000 revolutions per minute, and the result was a depression of less than 0.02 inch in the metal, but an entirely dull and smooth diamond.

A number of other rare metals have been tried for making filaments and, while some, like vanadium and niobium, have proved to be failures, OSMIUM (whose chief use in connection with IRIDIUM has hitherto been in the manufacture of high-grade writing pens—fountain pens), has led to the creation of the osmium lamp, which, however, is more of scientific than of commercial value.

A so-called Wolfram lamp, the filament of which is made of the metal tungsten, has been perfected recently and a powerful combination of Austrian and German electrical works will bring these lamps on the market in opposition to the tantalum lamp; but as the patents relating to the wolfram lamp do not seem to be clearly defined as yet, little is known of its special features and advantages at the present time, though many predict its being at least equal in efficiency and economy to the tantalum lamp, and in addition thereto materially cheaper. The near future will show whether these claims are exaggerated or not.

There is another group of rare minerals which is of the utmost importance in the illuminating industry, containing the elements THORIUM, CERIUM, YTTRIUM, ZIRCONIUM and some others, and these minerals, on account of their physical character, are generally known under the name of "rare earths."

Monazite, occurring in the form of sand, is the only commercially developed source of the metal thorium, which, since its discovery in 1828, until about a decade ago, belonged to that class of rare metals whose existence was of consequence rather in the higher range of chemical speculations than for industrial uses; but the invention of the gas-burner mantle, commonly called Welsbach mantle, shifted it at once from this class of substances into that of products indispensable to our every-day needs. The discovery of the illuminating power of thorium oxide, if combined with other chemical compositions, especially a nitrate of cerium, which is likewise extracted from monazite sand, has practically been the salvation of gas as an illuminant in competition with other lighting methods.

During the early days of this industry the sands of Brazil furnished all the commercial monazite, and trade and manufacture were restricted by successful monopolistic efforts; but since North and South Carolina have entered the field as large producers of monazite sand and the Brazilian government has changed its restrictive policy lately, a new spirit has come over this industry and rapid strides in its development have been made during the last few years.

ZIRCONIUM, the chief constituent of the mineral zircon, and YTTRIUM, principally derived from gadolinite, furnish the main substance of the glower of the Nernst lamp, on which there exist more learned treatises than on any other lamp, but which has not come into general use. Its practical future is just as dark today as it was at the time of its birth, when an " illumination of the world " by it was promised.

The list of rare minerals which are or will soon be of importance in our commercial and industrial life is by no means confined to those enumerated above, but the study of the peculiarities of those remaining would require a predilection for chemistry. Be it sufficient then to just name one of the rest, viz., LITHIUM, well-known to everbody in the form of lithia-water and tablets. Four different kinds of stone contain the element lithium, also a metal, namely: lithiophilite, lepidolite, spodumene, and amblygonite; and while the first-named forms whole mountain ranges in the United States, it is of no commercial value. Lepidolite and spodumene are also found in comparatively large quantities, chiefly in California and the Black Hills respectively, and can be treated to advantage; but amblygonite is distinctly a rare mineral, unfortunately, since it is the one containing the highest percentage of lithia.

The lithia industry has experienced very peculiar phases since its inauguration. The United States having the largest supply of raw material, have exported " lithia stones " in considerable quantities to Europe and re-imported lithia salts; but about four to five years ago American manufacturers began to enter this field in an injudicious way, thinking that there was a practically unlimited demand for lithia preparations. They created such an overproduction that the world's markets have been glutted with lithia compounds since, and although, with but one or two exceptions, the American plants had to close down (and many in Europe also), years are necessary to free the markets from this " drug " on them; but we are now seemingly on the eve of a new era, and the United States may soon lead in the manufacture of lithia compounds and be able to export them to other countries instead of importing them, as has formerly been done.

EDITORIAL COMMENT

ROBERT P. PORTER'S admirable book just published, which arraigns "governmental interference with industrial development," is impressive because his evidence is drawn from a wide range of experience and time.* He takes the whole period of British municipalism—now about thirty years—and around the main theme of the results in the United Kingdom he groups the records of similar policy in the Colonies and on the Continent. Municipal and State gas works, electric-power and lighting stations, telephones, tramways, steamboats, housing schemes, mining, shopkeeping, have been fully tried out and tested, not by single instances merely but by their total outcome. And he finds that, however plausible the argument for the undertaking and however rosy the prospectus, the gross result is that the governmental enterprises "lead to stupendous financial liabilities, add to the burden of taxes, weaken municipal credit, bring about inequality of taxation, . . check industrial and scientific progress, stop invention, discourage individual effort, . . . establish an army of officials, breed corruption . . " The worst results of all appear when the State or city attempts not only to operate but to construct public utilities, with officially hired and superintended labor. Those who believe that policy can lead to efficiency and success should read Mr. Porter's chapter on "The Public Works Policy of Australasia."

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By the light which this book affords we may see more plainly how disastrous a retrograde step the Administration has taken with the Panama Canal enterprise. Little more than two months ago, Fullerton L. Waldo, fresh from the Isthmus, brought into our office his convincingly true picture of the work as it then was, full of health, energy, courage, and achievement. The engineering control, more nearly than ever before, had approached to the system of the great civil works described elsewhere in this number. The adoption of the contract plan was soon to furnish the supplementary means of keeping the execution on a corresponding basis of business economy and efficiency. And then—the tension between engineering and political ideals rose too high, and the connection was broken. Just where or how it happened may not be told, but the forces producing the result are certain. They are the same which are arrayed whenever political bodies undertake the control of constructive enterprises. Porter phrases it concisely: "Recommendations urged by the technical staff are ignored, and the personal efficiency of the latter is discouraged, so that the adoption of ordinary business principles is impossible." Then the technical chief, if his devotion to professional principles is greater than his desire for place or his subjugation to the Governmental system, gets out.

Indeed, if professional standards are to mean anything, that is all he can do. It is the peculiar province of the professional man to accomplish his employer's purposes by directing that employer's course. Would Osler manage a hospital, or Choate try a case, or Morgan finance a railway, on any other basis? If his technical knowledge and his skilled methods are to be set aside, he counts for naught. His mere name and personality is but a delusion and a snare. To remain would be to sacrifice his own reputation fruitlessly, and by reflection to compromise his calling. Withdrawal is the final protest, the public submission of the issue to the world, or to so much of it as may have an interest at stake. The United States should deal fairly between the parties and wisely for itself in examining thoroughly the issue on the Isthmus.

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* The Dangers of Municipal Ownership. Robert P. Porter, Director of Eleventh U. S. Census. The Century Co.

The President, acting wholly within the powers given him by the Spooner Act, has passed by the staff drilled under Stevens and familiar with the work, and has given army men all the upper posts on the Isthmus. An overwhelming military majority is placed on the Commission. All bids for contract construction are rejected. The decision is plainly to abolish the conflict between civil-engineering ideals and bureaucratic methods by eliminating the civil engineer and putting in the military man, trained under the departmental ways and tolerant of any conditions those ways may involve. As a soporific, this plan ought to succeed. It is inconceivable that a lieutenant-colonel of engineers should seriously withstand the Secretary of War or the Commander-in-Chief. A brigadier general or a rear admiral could not be strenuous before Congress if (say under the plausible influence of transcontinental railways) continuing appropriations for the Canal were cut so far that work languished and stagnated. His code forbids him to question the import of any policy of the Government, but exacts from him its strict execution. All honor to his splendid devotion—but will the outcome be speedy or economical building of the Canal?

Take the time and cost of any piece of work done under the Department of War; multiply it up to the proportions of the Canal, and look at the total. Ambrose Channel happens to be the nearest to this office, and will serve as well as any. It was undertaken in 1899 and is about half finished. Sixteen years may see it through. Measured roughly by comparative cost, the Panama Canal is fifty time as great: 16 × 50 = 800.

God bless the patience and the long-suffering of the army engineers! There are no finer fellows in the world. It is not the men who are to be criticized, but the system which is inseparable from the employment of these men—the red tape, the subordination of positive good to political expediency, the compromise between sound business and sectional interest, the frittering away of time in Congressional wrangling, the fractioning down of minimized estimates in Congressional appropriations. It may be the best possible system to fight under; but as a system to work under, it is utterly wasteful of time and money. And, if we mistake not, the President is especially anxious that the Panama Canal should be complete, ready for the passage of the heaviest ships, in the shortest possible time. He has gone a bad way about getting it!

And yet there is a way which promises sure success. It lies in eliminating friction, not by withdrawing the aggressive energy of the engineer, but by taking off the drag of the departmental system. It is exemplified by the great works outlined in Mr. Munby's article. Civil engineers, specialists of the highest standing, in control, responsible to their employers' purposes—responsible by their one priceless asset, their reputation for "getting results;" contractors of the highest type doing the work, responsible by bond for true performance; Congressional action concentrated on the one great issue of bonds; departmental methods limited to the supervision of the stated payments. It is the way all the large work of the world is done. The great railways employ it, because it gives them the surest results, in the shortest time, at the lowest cost. They employ it though they are essentially engineering organizations, officered by engineers, with an army of trained labor under their command.

Ah, the pity of it—that the Administration should rush in upon a policy by which organizations so much better fitted to handle a proposition of the kind yet fear to tread!

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE SUBSTITUTION OF ELECTRIC MOTORS FOR STEAM LOCOMOTIVES.

A DISCUSSION OF THE SUPERIORITY OF ELECTRICITY OVER STEAM AS A RAILWAY MOTIVE POWER.

Lewis B. Stillwell and Henry St. C. Putnam—American Institute of Electrical Engineers.

THERE are, at the present time, few subjects of such scientific and practical importance as the question of the electrification of steam railroads and there are but few to which the engineering world is giving more attention. Interurban electric lines have demonstrated their ability to compete successfully with steam railways on short hauls in both passenger and freight traffic and many steam railroads, in both Europe and America, have substituted electric for steam traction on their suburban and short interurban lines. The question of the electrification of steam railway lines usually presents itself in connection with particular cases where special conditions emphasize the advantages of electric traction, but the recent great development in electric machinery, particularly in railway equipment, has reached a point where it is not unreasonable to consider the possibility of the application of electric traction to the operation of railway divisions and even to trunk lines. The paper by Lewis B. Stillwell and Henry St. Clair Putnam, read at a recent meeting of the American Institute of Electrical Engineers, is an important addition to the discussion.

"Three-phase and single-phase alternating-current railway motors are now developed to a point where they fairly challenge the steam locomotive, even in long-haul freight service, in which class of work the direct-current motor hitherto has found itself unable to compete with success. The direct-current motor has demonstrated impressively, and on a large scale, its superiority to the steam locomotive, not only in operating single cars and short trains on lines of moderate length, but also in frequent and heavy passenger service in which the length of train is limited only by the length of station platform, while the motive power equipment far exceeds in power developed the limits hitherto established in steam passenger service.

"In the New York Subway, eight-car trains weighing 320 tons are in operation, equipped with motors developing during acceleration a tractive effort equivalent to a draw-bar pull of 55,000 lb. The heaviest passenger locomotive used on the Erie system weighs, exclusive of tender, 206,000 lb., of which 115,000 lb. is effective on drivers. Assuming the adhesion to be 20 per cent., such a locomotive exerts a draw-bar pull of 23,000 lb. The motors of the eight-car electric train of the New York Subway, therefore, exert a tractive effort equivalent to more than twice the draw-bar pull of this locomotive."

Discussing the earning power of electric lines, the authors mention eight important considerations which tend to secure for electric railways an increase of earning power over those operated by steam. These are, briefly:

1. The ability to run trains on close headway on electric lines gives a frequency of service which has a great effect in the creation of new business.

2. In electric traction, the elimination of

the unbalanced reciprocating parts of the steam locomotive makes it possible to operate safely at much higher speeds than are permissible on steam railways.

3. The cleanliness and the superior heating, lighting, and ventilation systems of cars and trains operated by electricity add greatly to the general comfort of passengers. The absence of smoke and gases of combustion frequently gives the electric motor a controlling advantage in tunnel service.

4. There are several considerations which lead to the conclusion that electric traction is materially safer, so far as the traveling public is concerned, than steam traction. The most important of these are:

(a) In rear-end collisions the power can be shut off with great promptness and there is much more danger of fire from the firebox of a steam locomotive than there is from a short circuit in electric traction.

(b) The absence of the steam boiler eliminates another element of risk.

(c) Signals can be seen clearly at all times on account of the absence of smoke.

(d) Electric heaters are much more convenient and eliminate a risk of fire.

(e) The use of electric light is much safer than that of oil or gas.

(f) The danger of derailment is far less on account of the elimination of the unbalanced reciprocating parts which tend to lift the steam locomotive from the tracks.

(g) Much better signal systems can be arranged than are possible on steam roads.

(h) Power can be cut off at will from a given section and this makes for additional safety in offering a means of averting head-on collisions under certain conditions.

On the other hand, the addition to the permanent way equipment of an electrical conductor conveying power to trains imposes a material risk not present in steam railway operation.

5. Careful investigation of the official records of the causes of delay on the Manhattan Division of the Interborough Rapid Transit system of New York which was formerly operated by steam, point to the conclusion that a more reliable service is to be had with electric motors.

6. The better acceleration possible with electric traction increases the capacity of the line by making possible a shorter headway and train interval.

7. An electric line can more easily collect and distribute passengers on account of the ability of the cars to stop at any street intersection or other convenient point.

8. Feeder lines can be easily established and a more convenient arrangement of local and express traffic can be made.

In comparing the costs of operation of steam and electric roads, the authors take as their standard of comparison the grand average results in steam operation in the United States for the years 1901-5, inclusive. A great part of the paper is devoted to an elaborate analysis of operating costs. Basing their conclusions on the best available data on electric railway operating costs, the authors state that the cost of electric operation is only 82 per cent. of that of steam. They then consider the question of the electrification of all the steam roads in the United States.

"According to our estimate if all the railroads of the United States were to-day operated by electricity, using the single-phase alternating-current system at the potential adopted for the equipment of the New Haven Railroad the energy required for operation being developed by power plants, such as are to-day in extensive use, and transmitted at potentials well within limits established in practical service, and if the rolling stock equipment consisted of locomotives and multiple unit trains fitted with motors and control apparatus no better than the best which now exist, the aggregate cost of operation, which in 1905 amounted in round numbers to $1,400,000,000, would be reduced by about $250,000,000.

"To accomplish this result power plants delivering about 12,500,000,000 kw.-hr. per annum would be required. Assuming the radius of transmission from power houses to be 150 miles the load factor in railroad service should be not less than 0.75, and taking this figure it appears that power plants capable of delivering a maximum output of about 2,800,000 kw. will be sufficient to operate the entire railway service of the United States as existing in the year 1905. The average output required is about 10 kw. per mile of line and 7 kw. per mile of track.

"In 1905 the average gross earnings of our railroads per mile of line were $9,598, and the average operating expenses $6,409. Our calculations lead to the conclusion that high class electric equipment now available would reduce this average cost to $5,265. The difference is $1,144 per mile of line, against which apparent saving must be charged the annual interest and depreciation of the power plant, the addition to permanent way equipment, comprising overhead construction and track bonding, the transmission circuits, and the substations with their equipment. Assuming 5 per cent. interest on cash cost of these items and allowing 5 per cent. for a sinking fund to cover depreciation of power house, with its equipment, and 2½ per cent. for a sinking fund to cover depreciation of the overhead construction and distributing system, the aggregate of fixed charges works out at $837 per mile of line. The saving in operating expenses, therefore, is more than sufficient to take care of the increase of fixed charges. In other words, it appears that the entire railroad system of the United States could be operated to-day at less cost by the electric motor than by the steam locomotive. That the railroads in general if so equipped would realize a large increase in earning power will be admitted by all who have given the subject intelligent attention.

"While our estimates have led us to the conclusion that, under average existing conditions of railroad operation in the United States, improved financial results would be attained by the substitution of the electric motor for the steam locomotive, the immediate and general adoption of the new motive power by our railroad companies is neither possible nor desirable. It requires no argument to demonstrate the wisdom of making haste with deliberation in a matter involving interests of such magnitude as those which are tied up with the transportation systems of the United States. Recognizing the magnitude of these interests, and having in mind the fact that the art of electric traction as applied upon a large scale to heavy train units is yet young, the point which we desire here to emphasize is the necessity of conservative and carefully considered action upon the part of all who may be called upon to advise in respect to the electrification of railways now operated by steam."

The paper concludes with a statement of the necessity for careful and intelligent standardization in electric traction and with a discussion of the advantages of a frequency of 15 cycles over a frequency of 25 cycles in electric railway operation on account of the better adaptability of the lower frequency to motor design. The authors conclude:

"In order that the question raised may be looked at in proper perspective the following estimates will be useful:

"For the equipment of the entire railroad system of the United States as now existing an aggregate power house output capable of supplying continuously 2,100,000 kw. would be required. Of the electric apparatus installed in the power houses, a change in frequency affects the generators, transformers, and a large proportion of the measuring and indicating instruments. It also affects the cost of the engine or turbine employed to drive the generator. At 25 cycles, the apparatus affected by frequency should cost approximately $30 per kilowatt. At 15 cycles it would cost on the average perhaps $33 per kilowatt. Cost of substation transformers would be increased approximately one-third, and in round numbers the total cost of turbines and electrical power house and substation apparatus would be increased from $70,000,000 to $80,000,000.

"If it be assumed that one electric locomotive will do the work of two steam locomotives, about 24,000 electric locomotives would be required to take care of the present railroad business of the country. Assuming the cost of the average electric locomotive to be $25,000, the aggregate cost of locomotives required would be $600,000,000. Allowing for the increased cost of the 15-cycle transformers, it would seem that the difference in cost of the average locomotive should be not less than $1,000 in favor of the lower frequency, or for 24,000 locomotives $24,000,000. This is more than twice the estimated difference in cost of power house and substation equipment.

"It seems entirely safe to say, therefore, that the aggregate first cost of electric equipment and of steam turbines will be decreased by a change from 25 cycles to 15 cycles. The operating cost will obviously be decreased very materially. At least three-fourths of the above estimated cost of electric locomotives, say $450,000,000, represents cost of electric equipment. It will be seen, therefore, that of the apparatus which our electrical manufacturing companies may be called upon to furnish, more than 85 per cent. is rolling stock. Obviously, any argument in favor of 25-cycle equipment which may rest upon existence of drawings and patterns and convenience in manufacturing should have comparatively little weight."

RECENT EUROPEAN LOCOMOTIVE DESIGN.

EXAMPLES OF IMPROVED ENGINES EXHIBITED AT THE NUREMBERG AND MILAN EXPOSITIONS.

Zeitschrift des Oesterreichischen Ingenieure- und Architekten-Vereines.

THAT considerable attention is being paid in Europe to the improvement of locomotive design was amply demonstrated by the exhibits of improved locomotives at the Nuremberg and Milan exhibitions. Articles in a recent number of the *Zeitschrift des Oesterreichischen Ingenieure- und Architekten-Vereines* illustrate and describe several of these engines and the following abstract gives a few examples showing the trend of modern European locomotive design.

Of the recent passenger locomotives built in Europe, there are two prominent types, the Atlantic and the Ten Wheel, the 4-4-2 and the 4-6-0 types; and while many of the four-coupled 4-4-0 type have been built, they are being gradually but surely replaced by these two styles. For several years locomotive experts in Europe have been making exhaustive service tests of compound cylinders and of superheated steam, and they appear to be so satisfied with the results of their experience that these two features are more noticeable than any others in present Continental locomotive design. Furthermore, while some designers in the United States are questioning the economy of steam at higher pressures than 185 lbs. per square inch, all new locomotives built in Europe are carrying pressures ranging from 215 to 230 pounds per square inch.

Some very interesting locomotives have come into use during the last year in France, Germany and Austria. One of these is of the Atlantic (4-4-2) type, a four-cylinder compound, with cylinders 14 3/16 and 24⅜ inches diameter by 26 inches stroke, driving wheels 82⅝ inches in diameter, a broad firebox with 42 square feet of grate surface, and 2,823 square feet of total heating surface and a total weight of 164,000 pounds. It was built for the Hungarian State Railways and, in accordance with a practice growing quite common, has the front of the stack, cab, and smokebox pointed for the purpose of diminishing air resistance. Another interesting fact about this engine is the use of a Vanderbilt tender. This is generally used for this particular group of locomotives, of which several are now in service and more are to follow.

The four cylinder compound Atlantic locomotive is not by any means an innovation, as a large number have been put in service during the last five years in Austria. The first was designed by Karl Gölsdorf, the compounding being according to his system. The more recent compounds, however, are larger and more powerful and have somewhat different proportions, embodying such changes as have been found desirable from service conditions.

For the Bavarian State railways a locomotive has been built of about the same tractive power and heating surface as the one first described, but somewhat heavier. In order to accommodate the larger firebox desired, a four wheel truck was put under the rear end of the engine; hence it is called a 4-4-4 modified Atlantic. It has a very long wheel base, 38 feet 4½ inches, but it is evidently sufficiently flexible to avoid excessive flange friction in going around curves. The cylinder and driving wheel dimensions are nearly the same as those of the engine first described, but the grate area is 50.6 square feet, and the engine weighs 185,000 pounds. It is equipped with a superheater.

The State railways of Belgium have put in service two designs of four-cylinder compound ten-wheel engines, the 4-6-0 type. One of these has all four cylinders set on the same transverse line, under the smokebox; the other has the well-known De Glehn arrangement of cylinders, that is the low-pressure cylinders between the frames and under the smokebox, and the high pressure outside the frames and back of the forward-truck wheels. They are both of about the same tractive power and weight and have high-pressure cylinders 14⅛ inches in diameter, low-pressure 23⅝ inches, and a piston stroke of 25 3/16 inches. With drivers 71 inches in diameter, this makes a powerful locomotive with steam at 228 pounds pressure. These are also equipped with superheaters. While many other locomotives were shown at Milan and Nuremberg, those mentioned represent the present trend of design.

One other type, the Prairie (2-6-2), which, like the Atlantic, originated on American railroads, has been tried to a limited extent, and the Florisdorf Works at Vienna have just built a few four-cylinder compounds for express service on lines with heavy grades of the Austrian State Railways. These engines more nearly resemble their American prototypes than any others in Europe.

One of the first features that causes comment on the part of an American examining these European locomotives is their extreme lightness and apparent delicacy of construction. The piston rods, side and main rods, all parts of the valve gear, as well as the wheels, are made of steel the tensile strength of which is much higher than any material available for such use in the United States. In the latter country, it is not only a question of the expense entailed by the use of such metal, but master mechanics and mechanical engineers are forced to admit that it cannot be procured outside of Europe. Further, in Europe, innovations on locomotives are tried out with the sole end in view of effecting economy of operation, and the enginemen as a rule take more interest in obtaining results and thus gaining premiums for themselves, than is the case in the United States. Hence the complications and cost of repairs for compound locomotives are much less than the coal saving effected by their use. The same is gradually being found out in regard to superheated steam, though it is not so clearly established as compounding, which is now standard practice in Europe.

It must be remembered, however, in considering locomotive performances, that the quality of the coal obtainable in most parts of Europe is excellent, not only the loose coal, but the briquettes that are in common use. While fuel is expensive, it is burned to the greatest advantage owing to the custom of not overloading engines, forcing fires and risking the various kinds of trouble that Americans have come to regard as unavoidable owing to their conditions of traffic.

INSURANCE OF LABOUR IN ITALY

NATIONAL REGULATION OF LABOUR INSURANCE IN ITALY AND ITS RESULTS.

Engineering.

THE question of the insurance of workmen against accident is one which has received little attention in America. Its importance has, of course, been recognized and a great many large employers of labour, particularly in the building trades, regularly insure their workmen in the ordinary accident insurance companies. The practice is, however, not common and no concerted or systematic action on the part of the employers has been taken to arrange some mutual or national scheme of labour insurance. Nearly all European countries, on the other hand, have established national systems of insurance to which all employers of labour are required to become subscribers. Italy is the last country to institute such a system and a summary of the Italian law on the subject is contained in a recent number of *Engineering.*

"The Italian law which deals with the compensation to workmen for accidents is dated January, 1904; in this law there are also grouped together all former decrees dealing with the question. It covers all industries and trades; all installations and enterprises in which there are more than five operatives; fisheries; all establishments in which motive power is used, and where over five persons are employed. In the building trades the employers are responsible, even when the number of operatives is below five, when work is being executed outside buildings, with the use of planking, fixed and movable scaffolding. The following are considered as operatives under the law:—All those who, either permanently or temporarily, are occupied for a daily wage, or on piecework, away from their homes; those who, although not participating directly in the work, superintend the work of others, provided their fixed wage does not exceed 7 lire (5s. 7d.) per day, payable in regular periods not exceeding one month; apprentices who take part in the work, with or without wages; and attendants on agricultural machinery.

"All employers of labour have to insure against accidents. Should the job not be permanent, an insurance has to be effected to cover the time it lasts. Those employers of labour who attempt, by direct or indirect deductions from the operatives' wages, to make the latter contribute to the cost of the insurance are liable to a fine not exceeding 4,000 lire (160*l.*). An incorrect declaration as to the number of men employed is also punishable by a fine of from 2*l.* to 40*l.*

"Insurance must be effected with the National Fund; but the following firms are exempted from this form of insurance: —Those who have instituted at their own cost private funds recognised by Royal decree, and who have deposited with the National Fund a guarantee consisting of State, or trustee, securities to an amount fixed by the Ministry of Agriculture, Industry, and Commerce. Such a fund must be able to provide compensation for accidents at least equal to that prescribed by the law to a number of operatives exceeding five hundred. The sum deposited as guarantee is in no case to be below that of five times the premium that would otherwise have to be paid annually to the National Fund when the operatives number two thousand, and three times the premium if the number of operatives exceeds two thousand; in both cases the minimum is 40,000 lire (1,600*l.*). There are also excepted from the obligation to insure with the National Fund the firms who have combined together for mutual insurance, on bases approved by the State, who employ at least four thousand operatives, and who deposit as security with the National Fund 10 lire (8s.) per operative insured up to a maximum 250,000 lire (10,000*l.*).

"The compensation for accidents paid the operatives is as follows:—In the case of absolute permanent incapacity for work, the compensation is equal to the sum of six years' wages—minimum, 3,000 lire (120*l.*). In the case of partial, but permanent incapacity for work, the compensation is equal to six times that part by which the wages are reduced, or may be reduced, by reason of an accident, the minimum to be 500 lire (20*l.*). Should the incapacity for work be complete, but, nevertheless, temporary, the indemnity paid the operative during the time he is out of work is a daily sum equal to half the daily pay he received at the time the accident occurred. When the accident has caused partial and temporary incapacity for work, the daily compensation is equal to half the reduction in the daily pay. In all accidents the contractor, or his representative, has to bear the cost of first aid and of a medical certificate. In case of death, the indemnity is equal to five years' wages. This sum is divided as to two-fifths to the consort (husband or wife), and three-fifths to the children who are under eighteen years of age, or who are physically or mentally incapable of working. Should there be no children, or should the latter be able to earn their living, half the indemnity is paid to the consort, and the other half to the descendants who were dependent upon the deceased. Should there be no children or descendants, but yet brothers or sisters of deceased who were dependent upon him, less than eighteen years of age, or physically or mentally incapable of work, the latter receive the remaining two-fifths, the consort taking three-fifths. Should there be no children and no other relatives as here stated, the consort would receive the whole of the indemnity. Should the deceased have been alone in the world, the indemnity is paid into the deposit and loan fund—a fund into which are also paid the fines above alluded to—to be used for indemnifying the operatives who would have received no compensation for an accident, by reason of the insolvency of their employers. This fund serves also for subsidising the associations who aid the operatives during the first five days of sickness; for providing prizes in favour of inventors of protective devices; and for subsidising the societies who supply medical treatment to injured operatives.

"Indemnity to apprentices is based upon the wages of the lowest paid operatives engaged on the same work.

"By annual wage is meant that paid during the twelve months preceding the accident, in cash or in truck, up to a maximum limit of 2,000 lire (80*l*.). In the case of operatives who had been employed less than twelve months when the accident occurred, but not less than six, the annual wage would be reckoned as 300 times the daily pay in cash or in truck, unless the wage had been agreed upon for an annual figure, the maximum in both cases being also 2,000 lire (80*l*.). When, from the nature of the work, or for other reasons, the operative would be employed for less than six months, and whatever shape the compensation takes, the daily pay and annual wage are determined, if need be, by the Court.

"After a period of two years following an accident the operative and the insurance office are at liberty to consider the revision of the indemnity, should the estimate first arrived at have proved erroneous, or should the physical condition of the operative have undergone changes traceable to the accident. Should the operative die before the expiration of the term of two years from the day of the accident, his heirs-at-law may claim the revision of the indemnity; but their claim has to be put forward within two months from the death of the operative and still within the two years aforesaid.

"In the case of permanent absolute incapacity for work, and in that of permanent and partial incapacity, when the reduction on the annual wage for the fixing of the indemnity is at least half the said wage, the compensation above-mentioned is deposited by the insurance office with the National Provident Fund, instituted for affording relief to invalid or aged workmen, from which an annuity is paid to operatives, or their heirs-at-law. The compensation in question is due in all cases from the employers; the latter are compelled to insure in some accepted form against labour risks, but have a free choice with regard to the selection of an insurance company, or the formation of an association for insurance; both have, however, to be approved by the State.

"The law stipulates in a general way that safety devices shall be used for the protection of labour; it then details the compensation which has to be paid in cases of accidents, briefly reviewed in the foregoing. Judging from the comparatively numerous clauses which provide for judicial action in the event of disputes with reference to the application of the law; seeing also the various penalty clauses which apply to employers of labour—a very curious feature of the measure—difficulties were evidently foreseen and doubts were entertained as to the satisfactory working of the law in question. The law is, no doubt, found one-sided, both by operatives and employers. And in this connection it is interesting to put on record an article which appeared in a recent issue of the Milan technical paper *L'Industria*, written by an employer of labour, whose works occupy about 1,800 operatives. In this article the employer calls attention to frauds which have been perpetrated since the coming in force of the law of January, 1904. It seems hard to believe that workmen would get injured willingly with a view to receive compensation in cash; but it is difficult to find any other explanation of the facts. Firms who had always compensated their men many years before the law came into force, and at a period when protective devices were hardly used at all, do not seem able now to cope with the untoward increase in accidents and claims for compensation. The writer of the article in question gives the instance of his own works, and says: 'The experience gained on the subject in our own works is to the point; we have about 1,800 operatives, and at the present time the increase in claims for compensation under the law is 40 per cent. over the figure of several years ago, when we, of our own free will, and without State compulsion, insured our men, and when a large number of protective devices to prevent accidents now in use were unknown.' According to another report, the number of accidents caused by engines, lifts, motors, and shafting has decreased of late, while the number of falls and accidents in hand-labour have doubled, many other claims being for cases of arthritis and rupture, traced invariably by the men to their work for the employers, and for which they claim the benefit of the law, aided in this by unscrupulous medico-legal advisers.

"The National Provident Fund, above referred to, was formed in July, 1898; it is governed under a law dated July, 1901, completed by statutes and regulations approved by Royal Decree of May, 1902. All Italian subjects are free to pay deposits into the fund for securing an old-age pension or a pension in case of disablement, and the State has endeavoured to encourage thrift on the part of the subjects, not by adding to the individual deposits made by them, a given percentage, as is the case in Belgium, but by paying subsidies direct to the fund. Thus the State, in the first place, endowed the fund with 10 million lire (400,000*l.*) from sums in the Treasury from savings and deposit accounts, and also part of the profits of the Post Office Savings Bank. Various other payments and contributions have been, and are being, made to the fund in question; among others may be mentioned a tenth part of the credit for public worship."

THE REVIVED CHANNEL TUNNEL PROJECT.

THE SUPERIORITY OF A TRAIN FERRY SYSTEM OVER A RAILWAY TUNNEL AS A MEANS OF COMMUNICATION BETWEEN ENGLAND AND THE CONTINENT.

J. Wolfe Barry—The Nineteenth Century.

TWENTY-FIVE years ago, when a tunnel under the English Channel affording railway connections between England and the Continent was first proposed, *The Nineteenth Century* was one of the most vigorous opponents of the project. Recent events have again brought the question into prominence and the February number of that magazine presents a symposium of articles dealing with the military, political and financial aspects of the scheme. The following extracts are taken from an article by Sir John Wolfe Barry in which he discusses the possibilities of a train ferry system as opposed to the tunnel project.

"Leaving the military issues to others, I would point out that physically the difficulties in making the Tunnel might prove to be insuperable, for if any serious fissure in the chalk were encountered, no human beings could work under such a water-pressure as would be developed. I do not mean to prophesy that such a fissure will be met with; on the contrary, I think the information collected points the other way, but the non-existence of a fissure cannot be demonstrated until the full-sized Tunnel is completed throughout its entire length, and even the making of a heading from shore to shore will not guarantee that no fissure will be encountered in the larger cross-sectional area of the Tunnel itself. No one can deny the possibility of such a disaster, and it is a matter which certainly ought to be considered as of great weight in the balance of pros and cons of a Channel Tunnel.

"Then again there is the financial side of the question, assuming that all is well in the matter of construction. Is it possible that the net realizable traffic from a Channel Tunnel can pay interest on such an expenditure as is talked of, say sixteen millions of pounds, or on a cost of some 600,000*l.* per mile? Under the circumstances of the case, and with water competition both for goods and passengers still remaining, it seems to me impossible that the financial result can be even moderately successful. So far as this country may be asked to bear its share of the financial burden, it may be said that the capital expenditure and working expenses should be apportioned in view of the mileage affected, inasmuch as the Tunnel is expected to increase the traffic on the mileage of the existing railways in the two countries. If so, the shorter mileage between London and Dover as contrasted with that between Calais and Paris would indicate that the lion's share of the expenditure should fall on France. However this might be arranged between the two nations, the expenditure of 16,000,000*l.* of hard cash for improved means of communication—while the sea competition will always exist not merely between Dover and Calais, but also between all the ports of the two countries, strikes me as a financial difficulty of the first order. From this point of view the Channel Tunnel is obviously very different from the great tunnels which pierce mountain ranges."

A tunnel is not the only means by which improved communication facilities may be obtained. A railway ferry offers most of the advantages of a tunnel and avoids many of its difficulties. A Channel ferry was proposed in 1872 by Sir John Fowler and was again advocated by him in 1882 when the tunnel agitation was first at its height.

"Much has happened since 1882, and the views of that date have been amply borne out by much subsequent experience. We know of railway ferries in many countries by which both goods waggons and passenger railway rolling stock are conveniently interchanged across intervening seas and lakes for distances far exceeding that between Dover and Calais, and under conditions of sea exposure at least as great as between Dover and Calais. On the line of communication between Berlin and Copenhagen, as an instance, but also in many situations, we know that, besides the ordinary rolling stock, restaurant and sleeping cars cross the ferries, and that passengers habitually make their journeys in the cars.

"It cannot thus be denied that the scheme of a railway ferry across the Channel is perfectly feasible, and could be made convenient and even luxurious, avoiding all break of bulk for goods, and all change of carriage by passengers, unless a change to the deck of a large steamship be preferred. Sir John Fowler proposed to treat his ferry ships for passengers as large railway stations, with waiting room, refreshment rooms, and every modern requirement. The only obvious drawback is that all risk of sea-sickness cannot be eliminated by a railway ferry. But with ships of the large size required for the traffic between England and France, the chance of sea-sickness would certainly be immensely diminished, and its discomforts would be palliated by improved cabin accommodation for those who could not sleep in a sleeping car through the hour of sea transit, or could not afford the expense of a *train de luxe*. I do not wish to advance the idea that in heavy weather a large steamer will not occasionally be unpleasant between Dover and Calais. That sea-sickness, however, would be very greatly mitigated there can be no doubt, and we may well ask whether, for the total elimination of occasional sea-sickness of an hour's duration for a comparatively small number of persons, it can be worth while to spend so many millions or to incur grave national risks."

Dover harbour is much better fitted today for the establishment of a railway ferry than it was in 1872 and only a small amount of alteration would be necessary. At Calais better harbour accommodation than at present exists would have to be arranged for. Boulogne, which is four miles farther from Dover than is Calais, has much better harbour works than the latter, but not a sufficient depth of water. Both French ports are important railway centres, Calais for lines to Belgium, Holland and the North of Europe, and Boulogne for lines to Paris, Switzerland, and the South of France.

"With the knowledge of what can be done on sandy shores by a modern dredging plant, it is, I venture to say, merely a question of which position offers the greatest advantages, all things considered. We have only to look at the development and maintenance of deep water approaches to such ports as Ymuiden, Dunkirk, Liverpool, Durban, and Port Said, all on sandy coasts, to see that a good French harbour for the railway ferry presents no difficulties, and would not involve more than a very small fraction of the cost of a Channel Tunnel. It is obvious that money spent on any of the French ports would be for the advantage also of general trade, which is a point not to be lost sight of by our allies in considering the cost of installing a railway ferry with large ships.

"It must, of course, be admitted that the journey would be shorter in time by a Channel Tunnel; but here, again, the comparative shortening is not of much importance. The ferry would, I suppose, provide a speed of twenty-three knots, or nearly twenty-seven statute miles, an hour, and the railway speed through the Tunnel may be assumed at about forty-five statute miles an hour. If we may assume that some stoppage for the exchange of electric engines and other matters takes place on the railway at both ends, such stoppage would, wholly or in part, counterbalance the time expended in running the trains on to and off the ferry steamers. Considering the relative velocities of the train and ship, we may probably with sufficient accuracy arrive at a difference of time of about thirty minutes in favour of the Tunnel route. . . . . As in the case of sea-sickness, it does not seem reasonable to incur the risks and cost of a Channel Tunnel for a saving of half an hour, more or less, for passenger traffic. . . . .

"There is one other matter to which allusion has not been made—viz., the comparative working expenses of a tunnel and a railway ferry. It is a question which must, I think, remain indeterminate. In the case of the tunnel the traffic would be conducted over adverse gradients of considerable length in one or other direction, the cost of which is calculable, but we have no data for the expense of ventilating so long a tunnel, to be worked, no doubt, electrically, but approached at both ends by gradients descending to a very considerable depth. The wind and weather on the two coasts will much affect the question of ventilation from day to day, and we also cannot know what (if any) pumping of infiltrated water in the tunnel may be required. In view of the rainfall and land water on the approaches and condensation, we may, I think, be sure that provision for pumping will be a necessity, but what the annual cost of it may be it is impossible to say. In working the ferry, on the other hand, there would be the expenses of a separate organization of ships, of shipping and unshipping the trains, of harbour dues, and insurance against sea risks.

"On the whole, I think that for the present purposes the working expenses may, in the comparison of the two projects, be neglected. It is impossible, as I have said, with our present knowledge to indicate on which side the advantage would be. In the case of the ferry a fairly correct estimate of annual expenses might be made for a given traffic, but this is not the case in regard to a tunnel such as is proposed.

"The conclusion from all the above considerations must, I think, be that for a very small part of the cost of a tunnel a railway ferry with the most modern improvements could be installed which would fulfil almost all that a Channel Tunnel could provide. In those things in which the ferry would fall short the issues are nearly immaterial. There could be no difficulty in estimating the cost of the ferry, with its harbour works, and the working expenses could be arrived at, while its beneficial effect in uniting the two countries and increasing interchange of traffic must be undoubted. On the other hand, there are many undefined eventualities in the case of a tunnel, the expenditure must be enormous, and success cannot be guaranteed."

ELECTRIC-POWER DEVELOPMENT IN SAVOY.

THE THURY SYSTEM OF HIGH-TENSION DIRECT-CURRENT GENERATION IN FRANCE.

J. A. Montpellier—L'Electricien.

THAT portion of France adjoining Italy and Switzerland, south of the lake of Geneva, and comprising the provinces of Upper and Lower Savoy, contains a large number of streams available for power development, and engineers and capitalists have not been slow to take advantage of the opportunities afforded. Most of the streams have their sources in the Alpine glaciers, and while many are small, their fall is considerable, and they may be said to furnish practically all the power required in the region mentioned. The industries of the district are varied; many small mining and manufacturing plants are operated by electric power and, in addition, the lighting of the many villages and towns constitutes a considerable part of the load at most stations, and the entire load at a few of them. A portion of the Paris, Lyons, and Mediterranean railway, from Fayet to Chamounix, is operated by electricity from one of the numerous water-power plants. There are fifty-four generating stations scattered throughout the district; of these all but four are run by water power exclusively, one is steam driven and three have auxiliary steam plants for use during periods of low water.

Considering the area to be served, it might be more economical and more satisfactory to have fewer generating stations; but in addition to the consideration of the limited power available at most localities in Savoy, it must be borne in mind that the consolidation and centralization of public service undertakings are not such simple matters in Europe as in the United States. In the former, the policy of industrial development as commonly carried out is to treat each province or canton as a unit entirely independent of the others.

In *L'Electricien,* from recent issues of which these facts were obtained, a comprehensive enumeration of the hydro-electric generating plants is given. Of the fifty-four stations, mentioned as supplying the two provinces of Savoy, forty generate direct current, one at 57,600 volts, two single-phase alternating, and twelve, three-phase alternating current. Most of the direct-current transmission is over short distances, and on the three-wire system, with 220 to 250 volts between outside wires; for the longer transmissions alternating current at from 2,000 to 12,000 volts is employed, the usual rate of alternation being fifty per second. Some of these alternating plants also supply several substations, and as regards generators, transformers, etc., present no very new or striking features, being representative of the best European practice of to-day.

At Moutiers, on the Isére river, which near this place affords a head of 215 feet, there is an installation generating 6,300 horse power that in its electrical features is novel, well worked out, and worthy of more than a passing notice by engineers. Turbine-driven generators furnish direct current at 57,600 volts which is transmitted to the city of Lyons, a distance of 112 miles. This high-tension current is developed according to the scheme devised by M. Thury, several groups of generators being arranged in series, the voltage desired being attained by connecting a number of machines in each group and then connecting the groups in series. At Moutiers the installation consists of four turbines of 1,570 horse power each, driving four groups of generators, each turbine driving one group of four machines connected in series. At normal operation, the dynamos run at 300 revolutions per minute and each generates direct current at 3,600 volts. Thus for each set of four dynamos connected in series, the final voltage will be 14,400 volts. Since four sets of machines are thus connected, the total effective voltage at the switchboard is 57,600 volts. The dynamo shaft is direct connected to the turbine shaft by means of a clutch, but this clutch is so constructed as to allow a slip to occur as soon as the torque on the shaft varies appreciably from that of full load. This feature does not, of course, render unnecessary the circuit-breakers which are installed, but it probably helps to relieve the strain in the case of a bad short circuit by slowing down the dynamos. In such a plant as this, furnishing direct current at 75 amperes and 57,600 volts, it is vitally important to have good regulation. A small motor is installed, connected through gears to the gates in the conduits leading to the turbines. This motor is controlled by the current traversing a solenoid in the main circuit, and as the main current varies, the plunger of the solenoid operates upon the motor circuit so as to cause the motor to revolve in one direction or the other, open or close the gate to the turbine and thus alter the speed of the dynamos to suit the requirements of each case. The plant has been in operation since last April, and this feature is said to be very satisfactory.

With such a high voltage as is developed by the generators in this installation, the question of insulation becomes a serious one. Each generator is set upon porcelain blocks resting upon asphalt bedded in cement, and the same care is bestowed upon all leads and mains on and near the switchboard. No troubles with insulation appear to have been experienced, although the problem of insulation in a direct-current plant is somewhat different from that in one developing alternating current, where the high tension "danger zone" can be confined to the transformers and outgoing line.

The transmission line is of copper wire, 0.354 inch in diameter, secured to triple porcelain insulators on wooden poles. It is subdivided into several sections at the ends of which either conductor may be grounded in case of damage to any part of the line. In such a case, one terminal of the generators may have to be grounded and the whole current, 75 amperes, transmitted in this way.

Whatever its economic results may be, this installation has been very successful from a mechanical and electrical point of view; and the simplicity of the direct-current machinery appeals to one on account of the absence of intermediate transforming apparatus inseparable from high-tension alternating-current plants.

BLOCK SIGNAL SYSTEMS IN THE UNITED STATES.

A SUMMARY OF THE REPORT OF THE INTERSTATE COMMERCE COMMISSION RECENTLY PRESENTED TO CONGRESS.

Railroad Gazette.

IN June, 1906, a resolution of the United States Congress empowered the Interstate Commerce Commission to conduct an investigation of the block signal systems in use in the United States, and a report of the results of the investigation has just been presented. The report includes a mileage table of block signal systems, a review of the history of block signals and of present practice, a discussion of automatic stops, and an appendix containing technical notes on signal appliances and some accident statistics. The presentation of this report is very timely in view of the numerous disastrous collisions which have occurred within the past few months and some of the conclusions and recommendations of the Commission, as abstracted in the *Railroad Gazette,* are given below.

"The salient facts shown in the statements which have been received from carriers are that—

(1) Fifty of the principal railroads of the country have introduced and are using the block system on their important lines, though with considerable difference in details of apparatus and methods of operation.

(2) The telegraph block system is operated at moderate expense, with a great improvement in safety as compared with former methods of train control.

(3) Automatic block signals, almost universally looked upon in this country as the highest exemplification of the art, have been and are being developed with great energy and skill and liberal expenditures of money.

(4) Automatic signals are superseding the telegraph block system to some extent, and seem destined to do so increasingly in the future.

(5) Thirty roads of considerable length and importance have not yet adopted block signals of any kind.

(6) The block system has proved decidedly profitable even on lines where the signal equipment is not complete, this being accomplished by careful adherence to modifying rules making provisions against the deficiencies of the block system and by the continuance of the train despatching regulations which were used before the block system was adopted.

"It is proper to add that all of the railroads continue in force their rule requiring that when a train is unexpectedly detained a flagman shall go back with a red flag or lantern to stop any following train; though, as the accident records show, flagmen have repeatedly failed to stop trains that have wrongfully passed block signals.

"The main facts which have been elicited concerning the present policies of the railroads of the country in respect to block signaling are:

(1) The principal railroads use the block system on their lines of heaviest traffic, and most of them report that it is economical.

(2) Many of these roads use it also on lines of light traffic and some are rapidly extending it.

(3) All railroad officers deem the system an improvement over any other method of guarding against collisions. In other words, they consider it a means of safety.

(4) Many say that it has reduced the number and cost of collisions.

"The controlled manual system is used on the four-track lines of the New York Central & Hudson River and the New York, New Haven & Hartford. These are the principal examples of this system in the United States. It is, of course, equally adapted to two-track lines. The electric train staff, which is a type of controlled manual apparatus, is used on 100 miles of a single-track division of the Southern Pacific and on short sections of other roads. The train staff is universally approved as a safety device, but its failure to secure more general recognition appears to be due to a general feeling that the controlled manual apparatus which is used on double-track lines is perfectly adapted to single-track work, and is superior to the staff in that trains need not be stopped or slackened for the purpose of delivering the staff.

"With regard to the telegraph block system, most of the roads using it show records of long continued immunity from collision, but the 13 collisions which are referred to in this report, details concerning which are given in the appendix, with others occurring more recently and still fresh in the public mind, compel us to recognize that the system is not perfect.

"The only reason specifically formulated by any railroad manager for not introducing the block system is financial inability, except in the case of lines on which the passenger business is extremely light. Looking at the policies of some roads as they are known and at others in the only way in which they can be interpreted in the light of facts, it is quite clear that, generally speaking, the roads which have been dilatory in adopting the block system or in extending its use have simply pursued that temporizing policy which postpones appropriation of money until necessity will permit of no further postponement. An appropriation for the erection of block signals or for the expense of maintaining them is not viewed with favor because railroads operating without such signals have, in many cases, made fair records for a long time. It is true that important railroads have carried thousands of passengers for many years, with no block system, without fatally injuring a single one of them in a collision. Such a record is justly regarded with pride; but a single collision ten years hence, which is an admitted possibility, would extinguish the pride and becloud the record of the past.

"Many important roads have introduced the telegraph block system with the expenditure of very little money, simply by establishing a few new telegraph offices. There are also cases where a road, which has apparently held the view that the block system is impracticable by reason of its cost, has quickly changed its policy after the occurrence of a collision on its own line. It is true that roads which introduce the block system without increasing their telegraph facilities usually find themselves obliged, for a part of the time at least, to run freight trains under permissive blocking (which, strictly speaking, is not block signaling at all), but the action of such roads is significant because it marks decided progress. Their imperfect system protects passenger trains and it educates trainmen to the need of a space interval for all trains.

"A number of prominent roads which have shown enterprise in safeguarding their more important lines by means of block signals are continuing the old methods on other lines. A disastrous collision in the State of Indiana in November affords a striking illustration of this fact. A few roads which enjoy ample prosperity have as yet done little or nothing in providing block signals.

"The present investigation has been conducted for the purpose of setting forth the actual facts under present practices, and of affording the best guide as to what can or should be done to improve the safety of travel on the railroads of the United States. The conclusions reached confirm the views which have been heretofore expressed by the commission in its annual reports for the years 1903, 1904 and 1905. In its report for the year 1903 the commission presented the draft of a bill which provides for the introduction of the block signal system and also for the exercise of supervisory power by the commission through the employment of suitable agents and inspectors.

"Supervision is necessary, not only to insure that the specific requirements of the law are complied with, but also because of differences in methods of construction and operation and in the standards of perfection and safety on different roads where the block signal system is already in use. This point was not especially emphasized by the commission at the time the bill was laid before Congress, but the present investigation has more clearly emphasized the need of such supervision. The differences of practice, etc., are reflected in the results of operation. In reporting the faults of signals and errors in operation, different companies make widely different showings. This is a vital matter in which the function of the government in securing publicity is a particularly useful one, and in which no authority other than the government can act efficiently. To investigate accidents, as is done in England and to some extent by state commissions in this country, may be called an indirect method of securing information as to the efficiency with which safeguards to life and property are administered. To investigate signals and signal practice directly, without regard to accidents, would be a more direct method of promoting safety. Accidents should be investigated, for they increase so rapidly year after year that the record is looked upon as a reproach upon our American system of railroad management; but it is even more logical and reasonable to investigate signal practice, for, as regards the worst class of accidents, namely, collisions, investigation and regulation which look to prevention are chiefly of value. Investigation to this end is needed under four heads, namely:

(1) The telegraph block system on the larger roads (mainly double track) as regards the personnel and the routine; the use or non-use of distant signals, and the practice of permissive block signaling.

(2) The telegraph block system on single-track lines and minor roads, as regards the personnel, the routine, distant signals and permissive signaling, and also as regards the use of time rules and despatchers' orders to make up for incompleteness in the block signaling arrangements.

(3) The automatic block system should be investigated on all roads with respect to the efficiency of the apparatus and of the methods of inspection and care, and the integrity of the records of signal operations in respect to their completeness.

(4) The automatic block system on single-track lines should be investigated with respect to the features named in the foregoing paragraph, and also as regards the use simultaneously with the block signals of despatchers' orders and other measures designed to prevent collisions irrespective of the block signal system.

"If the legislative enactment should not require the early introduction of the block system on all railroads, government inquiry should be pursued with a view to determine the necessity for its installation on particular lines or parts of lines on which it is not now in use. The principal and, indeed, the only argument against the enactment of a compulsory block signal law is that a large number of railroads are now making fair progress in the extension of block signals without compulsion. Certainly the roads which come within this class can have no fault to find with such a mild measure of compulsion as that provided for in the bill proposed by the commission; while as to roads which have taken no action, some compulsion should be employed to require them to bring their service up to a proper standard within a reasonable time.

"The question of the need of apparatus for automatic control of trains is a somewhat difficult one. Collisions occur occasionally under both the telegraph and automatic block systems, which an efficient automatic stopping apparatus might prevent. The locomotive engineman has most exacting duties. An individual runner may be far above the average in mental poise and moral character and yet may fail in vigilance or in judgment occasionally, and such failure may mean disaster. Again, the individual engineman may be efficient in a high degree, and yet the efficiency of a force of enginemen as a whole may be unsatisfactory. The engineer performs such an innumerable succession of important acts on every trip that, even with an infinitesimal percentage of failures, the 40,000 or 50,000 engineers of the United States may still be chargeable in the course of a year with a large aggregate of fatal and non-fatal injuries. Anything less than perfection is cause, at least, for investigation, if not for decided dissatisfaction. Every great accident due to an engineman's fault is followed by a strong public demand for the introduction of automatic train stopping devices. As previously shown in this report, such devices used to a limited extent, though not on interstate roads, seem to have given a fairly good account of themselves; but these records do not justify the commission in making any recommendation as to their use or non-use without a more thorough and complete investigation.

"The limited extent to which devices of this character have been used makes it practically impossible for the commission to obtain anything more than theoretical and technical knowledge concerning them. It is therefore apparent to the commission that Congress cannot be furnished with much further information concerning these appliances, which would appear (to be) extremely valuable, theoretically, without extensive tests conducted by officials of the government and at government expense. For this reason and because the resolution under which this inquiry has been made does not confer authority to make such tests, the commission, on January 3, 1907, addressed a communication to Congress recommending that supplemental legislation be enacted authorizing the commission or some other official body to supervise and conduct experimental tests of such safety devices as appear to be meritorious, and that an appropriation be made sufficient to secure the most competent experts and defray the other expenses incident to such a project. The commission can only repeat this recommendation, believing that such experimental tests would be of great value in determining the direction which legislation not now recommended should take in seeking to add to the safety of railroad operations.

"The recommendations of the commission for immediate or early legislation are summarized as follows:

(1) That the use of the block system should be enforced on the passenger lines of the country, and that the time to be allowed for final compliance with its compulsory features should be made three or four years from the present.

(2) That with or without the passage of a law requiring the use of block signals, there should be a law authorizing an official investigation of train accidents, and providing for the employment of competent men to perform the duties imposed by such an enactment.

(3) That investigation by official tests of automatic appliances for the control of railroad trains should be authorized in accordance with the commission's recommendation of January 3, 1907, with an appropriation of sufficient amount to conduct such tests in a proper manner."

A LOW-SPEED HEAVY TRACTION ENGINE.

A STEAM-DRIVEN TRUCK USED IN GERMANY FOR HAULING HEAVY WAGONS.

H. Heller—Zeitschrift des Vereines Deutscher Ingenieure.

THE use of traction engines on public highways has been much more general in Great Britain and Europe than in the United States, and such a machine, before the common use of motor cars, was rather rare; but with better roads than are at present available, and a more careful consideration of the cost of hauling merchandise, there may be, in the future, a demand for a simple, powerful motor car, built to haul one or more loaded wagons. An article in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure,* describes a traction engine for use on ordinary highways in Germany. The engine is heavy, and very substantially built; and on a good road, should give very economical results based on ton-mileage.

It is a four-wheeled vehicle made up of two parts, each carried by an axle, the two being flexibly connected by a steel beam or reach. The surfaces of contact between the front and rear portions are shaped to arcs of circles and are provided with intermeshing teeth, so that the two articulated portions are kept in alignment with the center of the roadway, while adjusting themselves as a whole to the curves. The effective wheel base of the machine is thus made quite small.

The forward half of the vehicle carries a Davies water-tube boiler with 161.4 square feet of heating surface, which is fitted with a furnace for burning crude oil. The chauffeur occupies a roofed platform just back of the boiler. The steering wheel is mounted vertically, with the throttle and other fittings within convenient reach. The engine is located at the back of this platform. It is a double motor, consisting of two four-cylinder single-acting engines, each with cylinders 3⅜ inches in diameter and 3¼ inches stroke, taking steam at 220 lbs. pressure and developing 40 horse power at 800 revolutions per minute. Each engine drives one wheel of the forward part of the vehicle through double reduction gears and a chain drive. The steering wheel is connected, through bevel gears, to an inclined steering post, and the latter in turn, through another gear, transmits motion to a transverse screw shaft, threaded through a box or nut built into the reach of the vehicle. In this way, the change of direction of the parts is accomplished.

The rear half of the motor-wagon is a tender, carrying 528 gallons of water and 211 gallons of fuel oil. The weight is transmitted to the axles through half elliptic springs of massive construction. The whole engine is 25 feet long and 6 feet 10 inches wide, outside measurements, with a wheel base of 12 feet 10¾ inches. The driving wheels are 5 feet 11 inches in diameter and have tires 10 inches wide. The weight, which amounts to 8¼ tons on the forward axle and 5½ tons on the rear, is so distributed that it ought not to damage a well-built road to any extent.

This engine is intended to haul two trailers, which are built on the same principle as the motor vehicle. Each trailer consists of two articulated single-axle vehicles, jointed in the middle and secured together by a steel beam pivoted at its ends over each axle. Couplings are made by means of a spring draw bar with short link and pin coupling. Each vehicle is equipped with a powerful brake operated by a handwheel. The engine can haul, on a level road, a load of 17½ tons in the two trailers at a speed of 4.3 miles per hour.

It is doubtful whether such wagon trains will ever become common in the United States. Certainly their excessive length might be an objection to their use, particularly in cities and towns, since the engine and two vehicles have a total length of 72 feet 2 inches. When the rights of the public are taken into consideration, the use of many such trains would approach a monopoly of the road, and seriously raise the question of overstepping the limits of allowable space for private advantage.

TESTS OF CONCRETE: SHEAR, AND BOND OF STEEL.

A SUMMARY OF TESTS RECENTLY CONCLUDED AT THE UNIVERSITY OF ILLINOIS.

Bulletin of the Engineering Experiment Station.

THE latest bulletin of the Engineering Experiment Station of the University of Illinois reports the results of a series of tests, extending over a period of two years, on the shearing strength of concrete and the strength of the bond between concrete and steel. Notwithstanding the very extensive use of reinforced concrete as a building material, but little exact data as to its properties is available, and the information contained in this report is an important contribution to the literature of the subject. The general conclusions drawn from the tests, as summarized in the report, are given below.

It was found very hard to devise a method of testing concrete in shear so as to avoid the possibility of its failure either by crushing or in tension. Two methods of testing were finally decided upon after an exhaustive study had been made of all previous investigations on the subject. In the first, "the punching test," a hole was punched in a concrete plate or block. The second method, "the restrained beam test," consisted in breaking a short concrete beam which was restrained at the ends.

The punching tests were performed on blocks 13 inches square. Three forms of test piece were used: a plain concrete block 3 inches deep; a recessed concrete block 5 inches deep with a circular space 7 inches in diameter and 2 inches deep hollowed from the bottom; and a block similar to the latter but reinforced, just above the recess, by horizontal rods placed near the perimeter of the piece. In making the tests, the specimen was placed on a bed plate 1 inch thick, with an opening 6 inches in diameter in the centre. The load was applied through a spherical bearing block and a die 5⅞ inches in diameter formed the punching tool.

The test piece for the restrained beam test was 13 inches long and 4 inches square in cross section. It was bolted securely to bed plates above and below, with a 4⅛ inch opening between end reactions. The fracture was caused by the pressure of a 4 inch plate immediately over the opening in the bed plates.

The following are the general conclusions reached by the investigators.

"It is difficult to devise a form of test specimen and a method of testing which will satisfactorily determine the resistance of concrete to shear. The difficulties lie in the inability to secure an even distribution of the shear over the shear section, in the high cutting and bearing stresses developed, and in the complications formed by the compressive, tensile, and bulging and bursting stresses developed. The forms of test specimen here used are not fully satisfactory, but information concerning the shearing resistance of concrete may be drawn from the tests as a whole, and tentative values selected. A test specimen in the form of a beam and in which the load is applied evenly over the depth of the beam instead of on the top is suggested.

"The resistance of concrete to shear is dependent upon the strength of the stone as well as upon the strength of the mortar, and for the richer mixtures the strength of the stone probably exercises the greater influence. With hard limestone and 1:3:6 concrete 60 days old the shearing strength may be expected to reach 1,100 pounds per square inch, and with the 1:2:4 mixture 1,300 pounds per square inch. It seems very probable that the resistance to simple shear is considerably higher than this, and that tests made with the load applied evenly over the shearing section will verify this.

"Since the compressive strength of concrete is influenced largely by the strength of the cement and the shearing strength is much more influenced by the strength of the aggregate, it does not seem proper to express the shearing strength in terms of the compressive strength. However, this is frequently done and is of advantage in gaining a conception of their relative action. It appears that the shearing strength is, in general, at least 50 per cent. of the compressive strength, and that it may exceed 75 per cent. The apparent exception to this is explained by the high values obtained in the 1906 compression tests. These conclusions agree in a general way with the statement of other investigators that the shearing strength is as much as two-thirds of the compressive strength. Evidently the shearing strength of concrete is several times its tensile strength."

In the tests of the bond between concrete and steel, both plain rolled steel bars and smooth finished bars or shafting were used. The following summary of the results is given in the report.

"Little difference is found in the bond resistance per square inch of surface of bar in contact with the concrete whether the bar is embedded 6 inches or 12 inches. Evidently a length may be found beyond which the stretch of the steel would cause uneven distribution of the bond stress along the depth of the bar and cause failure to begin at the point of greatest stress in the steel and thus give results not representative of the real bond resistance. This limitation applies to length for use in experimental tests of bond. In simple beams the bond stresses are applied along the length of the bar, and stretch and bond exist together.

"The richer mixture of concrete gives somewhat higher bond resistance than the leaner: the values for the 1:2:4 concrete averaging 10 per cent. to 15 per cent. higher than for the 1:3:5½ concrete. For plain round mild steel rods, the average for the bond resistance ranges from 350 to 450 pounds per square inch of contact surface.

"The flat bars gave much lower resistance than round bars, but only three tests were made with flat bars, and these may not be representative. It may be noted that the results with flat bars are much lower than tests made elsewhere. It should also be noted that for a bond stress of 125 pounds per square inch the tensile stress developed in the bar was only 9,000 pounds per square inch.

"The value of bond resistance will depend upon the smoothness of the surface of the bar, the uniformity of its diameter and section, the adhesive strength of the concrete, and the shrinkage grip developed in setting. The effect of smoothness of surface and uniformity of diameter and section is seen in the tests made with cold rolled shafting and tool steel. The average bond developed with these was 147 pounds per square inch of contact surface, as compared with about 400 pounds per square inch for ordinary plain, round, mild steel rods. Not only was there a very noticeable difference in the smoothness and finish of the surface of the rods, but the section of the cold rolled shafting and tool steel was very uniform, the diameter not varying more than 0.0001 or 0.0002-inch at ¼-inch intervals throughout the length, while mild steel rods will vary as much as 0.0015 inch. It is to be expected that the smoothness and uniformity of section of drawn steel wire will operate to give low values of bond resistance, though, of course, as the section of wire is small compared with the circumference, the bond stresses developed when wire is used are relatively small. In reinforced concrete beams the bond stresses developed in beams failing by tension of the steel, diagonal tension of the concrete or other similar methods, amounted to from 73 to 193 pounds per square inch. Even at the breaking load, then, the bond stress developed in the mild steel rods was far below the bond resistance found in these tests.

"The bars began to slip when the maximum load was reached. After slipping began, the resistance to motion was still considerable. This running friction, taken when the bar had moved about ¼-inch, amounted to 54 per cent. to 72 per cent. of the bond developed in the case of mild steel bars, and to 32 per cent. to 49 per cent. in the case of the cold rolled shafting."

RECENT FAILURES OF REINFORCED CONCRETE.

A DISCUSSION OF SOME OF THE PRESENT FEATURES OF THE REINFORCED-CONCRETE INDUSTRY AND THE EFFECT OF FAILURES UPON IT.

Louis H. Gibson—Municipal Engineering.

WITHIN the past few months, two notable reinforced-concrete structures in the United States have collapsed during construction, the one the Hotel Bixby at Long Beach, Cal., and the other a structure for the Kodak Company at Rochester, N. Y. These two failures have attracted considerable attention and have been widely noticed in the technical press. In a paper recently published in *Municipal Engineering*, Mr. Louis H. Gibson comments on their causes and offers some timely criticism on the methods and principles of the promoters of the reinforced-concrete business generally.

The evidence with regard to the disaster at Long Beach is not conclusive. The finding of the coroner's jury was that the failure was due to the too early removal of the forms under the roof slabs; an independent investigator states that the design, construction, and materials were all faulty. Fuller evidence is available, however, in the case of the failure of the Kodak Building and the record is of such a character as to justify the expression of an opinion. The finding in this case was that the design was faulty; that all the metal indicated in the drawings was not installed and the installation of what metal was put in was carried out in an imperfect manner; and finally, that the concrete was generally bad, in some cases contained sawdust, leaves, and other foreign material, was improperly mixed, and was not always perfectly tamped. Mr. Gibson considers the knowledge and ability of the contractors for this structure to have been unquestionably sufficient to design and construct a building that would stand up and attributes their failure to use proper materials and proper care in construction to some fault in organization.

"These disasters do not discredit the general idea of reinforced concrete. They do not discredit the particular system or the kind of metal or the shape of the bars used. These happenings should in all justice have no ill effect upon the general idea of reinforced concrete or any part of the system, as such, that was employed on these buildings. These disasters will have no evil effect upon the mind of any one who carefully examines these structures or who carefully studies full and intelligent reports in regard thereto. The more carefully these structures are examined and considered as a system, the more friends will they make for the reinforced-concrete idea. Careful consideration, analysis and examination of the buildings themselves will supply abundant reasons for their failure without reflecting upon the general reinforced-concrete idea. Had these buildings been constructed on any other system the verdict of public opinion would not have been against the system, or the general principle or idea involved in the building, but would have been against merely the designers and builders of the structure. This is where the responsibility really belongs now and this is where in all fairness it should be placed. . . . . .

"One can not say that these disasters will not result in some immediate loss to reinforced-concrete buildings generally, but one may well question the ultimate loss. If they should serve to make contractors and builders more thorough, which now seems more than probable, it is reasonable to believe that the ultimate result will be beneficial to the efficient and high-minded builder. Nevertheless, the contractors for this work which has failed have cut out a large amount of unnecessary work for themselves and everybody else interested in special cement construction. . . . . .

"The spirit of promotion on the part of many engaged in the reinforced-concrete business has had a baneful influence on the engineering side of the work. On this account the work has suffered. This spirit of promotion has to some extent been of a hustling, bustling, hysterical character. It has been, in a way, successful in developing business, but it has not carried with it the spirit of high seriousness and thoroughness on the engineering and constructive side of the work. Certain corporations and contractors have been top heavy on the sales side of their business and relatively indifferent to the constructive side of the undertaking. A business of this kind may be built up along engineering and constructive lines even though the sales side be measurably neglected. If the conditions be reversed we will see what we have seen and are now seeing in instances of failure which, if often repeated, will result in general discredit to the business. The value of the reinforced idea can be realized by conscientious constructive methods, but it cannot be realized when the major part of the effort is directed to the sales department.

"We can not create a business related to engineering construction, but we may develop it. One of the most successful companies engaged in this work has worked solely along the line of engineering, and they have specialized on this department and always sought to give their customers the very best of engineering and construction. The world at large has heard but very little from them, but those who are led their way find them with large works in hand and evidences of a safe and profitable business. They have developed their business along engineering and structural lines and the man who runs will say that they have neglected the sales department. . . . . .

"Architects and builders have always been friendly to cement in its various relations and especially so to reinforced concrete. The general idea of reinforced construction in itself is interesting and so fascinating, in fact, that it at once secured a sentimental as well as a practical interest. The dominant reason, however, was practical, in that the cost was relatively low as compared with structural steel and clay fireproofing. This feature, especially, attracted capitalists to it. The Baltimore and San Francisco fires and other smaller conflagrations attracted favorable attention to concrete construction. The low structural and maintenance cost commended it especially to the builders of bridges and other engineering work. Thus, taking it all in all, no structural medium has ever come so rapidly and conspicuously into favor as reinforced concrete.

"The enthusiastic, general and hearty reception of this system has had a baneful effect on the character of the work done.

The readiness with which the building public has taken up with the reinforced-concrete idea has led many, who are temperamently unsuited to engineering and structural work, to organize companies and to dominate the policy of certain establishments. Now, it is not every promoter who can successfully manage any business and it is certainly true that the promoter's temperament and that of the engineer do not always belong under the same roof. This question of temperament is not thought of in this connection as related broadly to the question of integrity or honor. There is, nevertheless, a difference in the quality or variety of honor required in different occupations. The honor of the engineer is different and his temperament different from those of the banker or the business man. They carry a certain large measure of pride or sentiment and at times a disregard of profit for profit's sake, which do not fit into the qualities of the notably successful business man. It is true, however, that one may succeed in business merely because he is a good engineer, but no one is apt to succeed as an engineer merely because he is a business man."

LOCOMOTIVE FEED-WATER HEATERS.

A SYSTEM OF FEED-WATER HEATING APPLIED TO LOCOMOTIVES ON THE EGYPTIAN STATE RAILWAYS.

E. Sauer—Zeitschrift des Vereines Deutscher Ingenieure.

ALTHOUGH feed-water heaters have been tried in locomotive service in the United States, they have never come into general use, as the possible saving to be effected by their use is not great enough to offset their probable maintenance cost on account of repairs and loss of time in the shop. The locomotive-building firm of Henschel & Son, of Cassel, Germany, however, has applied one of these devices to a passenger engine recently built for the Egyptian State railways which seems to have given good results in fuel economy.

The locomotive is of the 4-4-0, or eight-wheel type, with cylinders 18 by 26 inches, boiler pressure 185 lbs. per square inch and driving wheels 6 feet 3 inches in diameter. It has a straight top boiler, with a grate area of 23.7 square feet and a total heating surface of 1,227 square feet. Its weight, in working order, is 123,000 lbs. The feed-water heating system consists of four principal parts in series, through each one of which the water is forced by a pump on its way to the boiler. A duplex pump, mounted on the running board on the right-hand side of the locomotive draws water from the tender tank and forces it into the first part of the heater, which consists of a vertical cylinder located between the driving wheels on the same side as the pump. The pump exhausts into a nest of tubes inside the cylinder, thus imparting the latent heat of the exhaust steam to the feed water circulating around the tubes. After being warmed in this first stage, the water is forced through a delivery pipe to another heater located just over the forward truck, in the usual place of the cylinders, this locomotive being inside connected, with the cylinders between the frames. From the second stage of the heater the water is forced to the third stage, an exactly similar cylinder located on the opposite, or left-hand side of the engine. These two parts of the apparatus are heated by the exhaust steam from the main steam chests, the exhaust being piped through them on its way to the stack. As only a portion of the exhaust steam is obliged to take this path, the back pressure on the exhaust side of the pistons is not increased to an appreciable extent. The feed water, after leaving the third part of the heater, next passes into a ring-shaped sheet metal chamber inside the smokebox and concentric with it. Inside this chamber is a nest of 265 tubes ¾ inch in diameter, placed longitudinally or parallel to the axis of the boiler, through which the water passes before being delivered to the check valve. A further accession of heat is given to the water as it goes through these tubes from the smoke and gases, which after entering the smokebox, pass forward through the ring-shaped chamber, and then back to the stack.

This arrangement is a complicated one, and the second and third heaters could be applied only to an inside-connected engine. It is difficult to see just where they could be placed when the cylinders are outside, as each cylinder is 6 feet 3 inches long and 15 inches in diameter. Furthermore, the nests of tubes in the four separate parts of the heater would be very likely to give trouble by leaking, and at best, their maintenance cost must be an item of considerable importance. It is found in service tests that with water in the tender tank at a temperature of from 70 degrees to 80 degrees F., the water can be delivered to the boiler at a temperature of about 250 degrees F.

A series of tests conducted with this locomotive in competition with one without a feed-water heater under similar conditions of service between Cairo and Alexandria, showed a saving of coal of 21.4 per cent. in favor of the former. The distance between the two cities, 129 miles, was covered by express trains in 3 hours 5 minutes, and the average weight of the trains during the test was 240 tons. The feed-water heater is said to cost, complete, $1,250, and the author of the article from which this description is abstracted states that the cost of coal at Alexandria was $5.38 per ton. Allowing 15 per cent. for depreciation of the heater, its annual cost becomes $187.50. The locomotives make an annual mileage of about 93,000 miles, and the author calculates from the results of the tests, a yearly saving of 274 tons of coal, amounting to $1,474. Deducting the annual charge for depreciation of the heater, there remains a yearly balance to its credit of about $1,286, an amount that would go a long way toward paying for the ordinary locomotive repairs. It is doubtful, however, whether the annual cost allowance of $187.50 would cover the whole cost of extra supervision and inspection, loss of time of the engine while in the shop, and delays on the road that would be entailed by the use of feed-water heaters on American railroads.

MARINE GAS PROPULSION.

THE DIFFICULTIES IN THE WAY OF APPLYING THE GAS ENGINE TO THE PROPULSION OF LARGE SHIPS AND A POSSIBLE SOLUTION.

A. Vennell Coster—Manchester Association of Engineers.

LAST month we reviewed in these pages an article dealing with the possibilities of the internal-combustion engine for marine purposes which considered only the mechanism and arrangement of the engine. A paper on the same subject, by Mr. A. Vennell Coster, recently read before the Manchester Association of Engineers, contains a discussion of fuels and gas producers and suggests an arrangement of engines which differs widely from that proposed in the former article. A few extracts are taken from Mr. Coster's paper with a view to showing how he proposes to solve the difficulties in the way of applying the gas engine to the propulsion of large ships.

"I feel confident that if a marine engineer were told that, by the introduction of the gas installation, he would obtain the following advantages, he would be more than satisfied with the substitution of gas for steam power.

(1) The ship driven with half the amount of fuel.

(2) Stand-by losses reduced over 75 per cent.

(3) Working pressure confined to the engine cylinders.

(4) No boiler tubes or main steam pipes to burst, or furnace crowns to collapse.

(5) No priming in a heavy sea way, or water hammer in pipes and cylinders.

(6) No more difficulties with the firing of boilers in a beam sea. Gas producers may be charged only twice every 24 hours, and the rolling and pitching of the vessel is rather an advantage than otherwise in assisting the fuel down from the charging hoppers.

"Firms of the standing of Messrs. Beardmore, Thornycroft, Yarrow, Crossley Bros., Nobel Bros., Sulzer Bros., Mr. H. Cherry and many others have already applied themselves to this venture, and the results so far have been by no means discouraging. There are still many difficulties to be faced and overcome, but they will be overcome. In this paper my proposal is to put before you such a scheme of marine gas propulsion, that the most cautious of us would be willing to risk a voyage by its means. What are the main difficulties?

1st. The construction of a gas producer able to gasify all grades of bituminous coal.

2nd. A simple method to cleanse the gas from tar, either before the introduction of the fuel into the producer proper; when in the producer; or after the gas has left the producer on its way to the engine.

3rd. Perfect control of the gas propelled vessel in starting, stopping, reversing and running at all speeds.

These are the three main difficulties in our way.

"Dealing with No. 1 and No. 2. If anthracite coal or coke is used these difficulties are entirely avoided, but with a limited supply of anthracite our wisest course is to leave it out of the question altogether. For marine purposes we must deal with the ordinary coal that may be obtained, not only in Wales, but in various parts of the United Kingdom, and the many coalfields scattered about the world. Bituminous coal is cheap compared with either anthracite or coke, and as I have already stated, it is the only possible fuel for marine gas producers. Its thermal value varies from 10,000 to 14,000 British thermal units per pound, and costs from 6/- to 7/- per ton. For many years gas engines have been driven by bituminous coal gas, and the difficulty has always been to get rid of the condensible hydro-carbons which would fill and clog the valves and gas passages of any engine they were allowed to enter. This problem is one that must be faced rather by our chemists than by our engineers, and many notable firms have already solved the problem, but not in that simple manner that would make the gas plant perfectly suitable for marine purposes. It is reported from several trustworthy sources that a simple solution has been discovered.

"Then there is the necessity of dealing with the many grades of bituminous coal, some suitable, many unsuitable. Shipowners would have to insist on a correct analysis being supplied prior to delivery, so as to ensure gas producing qualities.

"The third difficulty, namely:—Perfect control of a gas propelled vessel is our next consideration.

"One of the main difficulties that confronts the gas engineer in applying gas engines for marine purposes is that of reversing. With small powers it is possible to reverse by means of a reversible propeller, the engine having only one direction of rotation. There is naturally a very serious objection to putting the reversing gear in so inaccessible a position as in the propeller, but at the same time, there is undoubtedly a future for this type for river and coast work, if made simpler and more reliable. For higher powers up to say 500 horse-power units there is another system in vogue for reversing the propeller, namely—a reversing gear, which may be a combination of bevel or spur gear and friction clutches, is fitted somewhere on the propeller shaft within the vessel and in an accessible position. But for powers above 500 horse power the gas engines themselves must be made to reverse, for this dispenses with expensive and complicated clutches. There is no practical difficulty in reversing the gas engine, provided a sufficient reservoir of compressed air is at command.

"But the greatest of all difficulties in the application of gas engines for marine purposes, is the attainment of a sufficient range of mean effective pressures in the engine cylinders, so that like a steam engine, varying speeds, from full speed to dead slow, can be run without fear of stopping. We may reasonably assume that a maximum reduction of 60 per cent. of the mean pressure leads only to a reduction of 35 per cent. of the speed of rotation, or, if half the cylinders are cut out, the speed of revolution will be reduced by about 32 per cent. Then by reducing the mean pressure in the remaining cylinders, the result will be a reduction of the effective turning effort to 25 per cent. of that of full power, the speed of revolution will be something less than half that of full power. This reduction of speed is not satisfactory for marine purposes and it is doubtful whether gas engines could be run with so great a reduction of explosive charge. As an example, the marine gas engine in the 'Lord Antrim' (mentioned below), with normal speed of 150 revolutions, cannot safely be reduced below 75 revolutions per minute, because with a light fly-wheel and possible miss-fires, the engine has not sufficient momentum to carry it over the compression strokes.

"The following solution at once meets all these difficulties, whether the vessel has to run full speed or dead slow, by a practical manipulation of the speeds of independent engine units. In running some of them ahead and some of them astern any speed in either direction can be readily attained by the officer in charge of the vessel on the bridge, and without stopping, except during reversal, a single engine or the normal flow of gas through the gas producers.

"By this means the author attempts a solution (analogous to the turbine problem), but on different lines from those apparently adopted by builders of marine gas engines of 500 horse power and over. They rely on a large reservoir of compressed air for manoeuvering and working the vessel up dock, in narrow waters, or when running dead slow in foggy weather, because with one engine unit, as has already been stated, the vessel cannot be driven by gas much below half speed. But to depend on compressed air at these times, when engines and producers should prove not their inefficiency but efficiency, is to stultify the whole subject of marine gas propulsion."

Mr. Coster illustrates his solution by means of a concrete example. He takes the "Lord Antrim," a vessel 375 feet long by 47 feet beam and 28 feet depth. It is at present run by one triple compound engine, running 67 revolutions per minute and developing 2,360 indicated horse power. For this engine Mr. Coster proposes to substitute three gas engines developing the same horse power as the steam engine, but running at the increased speed of 150 revolutions per minute, the gas being supplied by four producers with their auxiliary apparatus, these producers having sufficient capacity to supply, besides the main engines, several smaller units for the driving of dynamos, electricity being used to drive the air-compressing apparatus, the pumps and other necessary machinery.

Each of the main engines runs a separate propeller shaft. "The central shaft is fitted with a larger propeller than the two wing shafts. These have two propellers carried on A frames from the bilge of the vessel, and do not project beyond the lines of the vessel, and are thus satisfactorily protected. It is possible, as already intimated, with this arrangement of machinery, to run the vessel at any speed from full speed to dead slow either ahead or astern, without stopping the engines except for reversing. For example: taking the propeller going astern as having only 50 per cent. efficiency when compared with going ahead, by running the centre engine full speed ahead, and the wing propellers about full speed astern, the vessel can be practically stationary. Then by slowing down the wing propellers to half speed astern, the vessel can be made to move about quarter speed ahead, and as these engines can vary their speed from 150 revolutions down to 75 revolutions per minute, any speed in any direction can be attained by the vessel without stopping the engines. In narrow waters, entering or leaving port, or working up dock, the vessel is under as complete control as if fitted with the latest steam engines, and with no fear of the quality of gas being reduced. With such an installation, which occupies somewhat less space, less weight, and about the same cost as a steam installation, but with about 50 per cent. less coal consumption, who would fear a deep-sea voyage if the machinery were in charge of experienced and capable marine gas engineers?

"There is no question in my mind as to what type of gas engine we should adopt for marine purposes, the simplest is the best, and there is no type so simple and satisfactory as the four-cycle or 'Otto' type, with its sequence of suction, compression, power, and exhaust strokes, taking place in each cylinder. This type of engine, with inverted vertical cylinders, has a mechanical efficiency of over 90 per cent. and a thermal efficiency of 33 per cent., and for a vessel requiring say 3,000 horse power units of six single-acting cylinders, with pistons of say 21-inch diameter by 24-inch stroke, would be suitable. But where larger powers are required, then tandem cylinder engines with open cylinder liners, having piston-rod and stuffing box between the tandem cylinders, where they can be easily inspected and adjusted, would be required."

CAR SHORTAGE.

A STATEMENT OF WHAT THE RAILROADS HAVE DONE TO RELIEVE THE SITUATION.

Arthur Hale—The Railway Age.

THE present shortage of freight cars is more general over the United States than any other the railroads have ever experienced notwithstanding the fact that it was foreseen. In 1906, the railroads ordered and obtained more freight cars than in any previous year, but the shortage still continues, and complaints seem to be as numerous and as general as ever. The blame has been placed upon the railroads and shippers equally, and the technical press has contained many suggestions as to how the situation might be relieved. Mr. Arthur Hale, writing in a recent number of the *Railway Age,* summarizes the efforts of the railroads to increase their facilities:

"If every railroad and every shipper or consignee handles the question solely from his personal point of view there will be no improvement of the present situation until it wears itself out; but there is an opportunity for great improvement if the railroads, the shippers and the consignees can each subordinate their desire for immediate individual gain and economy for the benefit of the whole country. I am, of course, more familiar with what the railroads can and ought to do than I am with what the shippers and consignees can and ought to do; and while I claim nothing particularly altruistic on the part of the railroads, I feel that I ought to call attention to the fact that besides the large additions to car equipment which I speak about, besides the large orders for cars which are not filled —and I think I am correct in my belief that the railroads will add another quarter million of cars to their equipment in 1907—the railroads have increased the wages of their employes by a very considerable amount this past year, thereby avoiding impending danger of general labor troubles. Furthermore, they have endeavored to add to their own and others' efficiencies by increasing the rates they pay each other for the use of cars. In the year 1905 the railroads were paying for the use of each other's cars the very small sum of 20 cents per day. It is true that this sum was charged for every day in the year, without allowances of any free time for loading, unloading, Sundays or holidays, and it is true that if any railroad delayed a car of another it could be made to pay $1.00 per day instead of 20 cents; but it was felt that 20 cents was not enough, and therefore on July 1, 1906, the rate was raised to 25 cents a day, or 25 per cent. As this has proved to be not enough to move the cars, a very considerable number of railroads entered into a further agreement, which took effect December 1, 1906, under which they are now paying each other 50 cents per day for the use of cars; and the roads in this agreement control nearly three-fourths of the cars in the country. Of course, many roads are directly benefited by this increase in the rate, but wherever one railroad gains another must lose, and to my mind the position of the railroads who have voluntarily doubled their expense for the use of others' cars is really public-spirited. These roads felt that a general increase in the rate of car hire between railroads would result in quicker movement of the cars and an improvement in the car supply; and despite an almost inevitable money loss to themselves, they entered into this agreement simply to improve the general situation.

"Another step intended to improve the general situation, and one which involves a very considerable expense, is the establishment of the American Railway Clearing House at Chicago by quite a number of railroads. This clearing house is to keep track of cars of the subscribing railroads on foreign lines, and will be in a position to locate such equipment, strike car balances and indicate a proper distribution of cars between all the railroads. I do not speak of various improvements in facilities which the railroads have made, involving improvements of their lines, sidings and terminals at very consderable expense. It is safe to say that wherever need has been demonstrated for facilities of this kind they have been added when the necessary capital can be secured.

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Bearings.

Bearings for King Edward VII. Bridge, Newcastle-on-Tyne. Illustrations and particulars regarding the method of allowing for the expansion and contraction of the girders. 500 w. Engr, Lond—Jan. 25, 1907. No. 82157 A.

Bronx.

The Bronx River Bridge at East 233d St., New York. Illustrates and describes improvements including a steel structure over the four track of the New York & Harlem R. R., a concrete arch over the Bronx River, and måsonry retaining walls. The river crossing is an elliptical concrete arch with interesting features. 600 w. Eng Rec—Feb. 23, 1907. No. 82526.

Drawbridge.

Drawbridge over the North Sea Canal, Amsterdam (Die Nieuwe Hembrug over het Noordzeekanaal en de daarmede in verband staande omlegging van den spoorweg Helder-Amsterdam). H. N. Francois. Description of a 455 ft. draw span over a ship canal. Illus. 5900 w. De Ingenieur—Jan. 5, 1907. No. 82336 D.

Failures.

Some Bridge Failures During a Heavy Cyclone in 1905, in Gujerat, India. Andrew Thomas. An account of the extensive damages due to an unusual flood, and the rapid construction of temporary bridges. Plate. 2000 w. Inst of Civ Engrs—No. 3633. No. 82041 N.

Newark, N. J.

The Jefferson St. Bridge, Newark, N. J. Illustrated description of a skew double-track, riveted, through-truss structure carrying the main line of the Central R. R. of New Jersey. 1800 w. Eng Rec —Feb. 16, 1907. No. 82416.

New York City.

Cost of the Brooklyn Anchorage of the Williamsburg Bridge, New York City. Francis L. Pruyn. Gives general plan and elevations, with details of cost. 2500 w. Engng-Con—Jan. 30, 1907. No. 82174.

Plate-Girders.

Web Stresses in Plate Girders. W. E. Lilly. Describes experiments undertaken to study the effect of various dispositions of stiffeners on the deformation of the web of the plate-girder. Ills. 4000 w. Engng—Feb. 1, 1907. No. 82253 A.

Quebec.

Handling Eyebars at the Quebec Bridge. Illustrated description of the methods used in handling the large eyebars in this cantilever bridge. 2500 w. Eng Rec—Feb. 9, 1907. No. 82225.

The Traveler for the Erection of the Quebec Bridge. Illustrates and describes a traveler of the gantry type, much the largest ever built. 2500 w. Eng Rec—Feb. 23, 1907. No. 82521.

Reconstruction.

Strengthening the Three-Hinged Arch Bridge Over the Mississippi River Between Minneapolis and St. Paul, Minn. Frank H. Constant. Drawing, illustration, and description of the reconstruction of this highway bridge to strengthen it to accommodate interurban cars on double track 4500 w. Eng News—Feb. 14, 1907. No. 82290.

Reinforced Concrete.

The Factory Street Bridge in Canal Dover, Ohio. Edw. Stingel. Illustrated detailed description of a four-span arched reinforced concrete bridge of the Thacher type, crossing the Tuscarawas River and the Ohio Canal. 1500 w. Eng Rec—Feb. 9, 1907. No. 82221.

Stone.

New Stone Bridge at Orleans. Illustrated description of a bridge consisting of 7 stone arches with clear openings of 144.4 ft., with particulars relating to the design and construction. 3000 w. Engr, Lond—Feb. 8, 1907. No. 82470 A.

Susquehanna.

New Lehigh Valley Bridge Over the Susquehanna River, Near Towanda, Pa. Philip H. De Witt. An account of the improvement in alinement and grades between Towanda and Wysox, with illustrated description of the new bridge of 14 spans of deck plate girders. 1200 w. R R Gaz—Feb. 8, 1907. No. 82200.

Viaducts.

Viaducts on the Guatemala Ry. at Rodeo and Station 1132. Illustrates and describes the special features of these viaducts. 1200 w. Eng Rec—Feb. 16, 1907. No. 82415.

The Erection of the Las Vacas Viaduct, Guatemala Railway. Drawings and description of methods used in erecting the steel work of the second tower, spans, etc. 2200 w. Eng Rec—Feb. 2, 1907. No. 82106.

Competitive Designs for a Reinforced-Concrete Viaduct in Milwaukee, Wis. Illustrated descriptions of two notable designs, for which prizes were awarded, for a long viaduct over the Menomonee Valley; one a Melan arch, the other a hooped-rib arch. 4000 w. Eng News—Feb. 14, 1907. No. 82293.

The First Prize Design for the Grand Ave. Viaduct, Milwaukee. States the requirements of the competitive designs and illustrates the first prize design for a concrete structure to carry Grand Ave. across the Menomonee Valley. 1200 w. Eng Rec—Feb. 9, 1907. No. 82223.

The Breydon Viaduct at Great Yarmouth. William Marriott and Theodore Graham Gribble. *Pro. Inst. of Civ. Engrs.* Illustrated detailed description of the construction of a steel viaduct of five spans over the estuary of the River Yare, called Breydon Water. 4500 w. Bul Int Ry Cong—Jan., 1907. No. 82546 E.

Washington, D. C.

The Connecticut Avenue Bridge, Washington, D. C. Illustrated description of the Portland cement concrete highway bridge carrying Connecticut Ave. across Rock Creek. The cost of this nearly completed structure is $800,000. 1600 w. Eng Rec—Feb. 16, 1907. No. 82411.

CONSTRUCTION.

Baths.

Swimming Pools. Jno. K. Allen. Considers the design and construction. Ills. 1200 w. Dom Engng—Feb. 16, 1907. Serial. 1st part. No. 82419.

Chimneys.

Chimney Construction. Illustrates and describes types of chimneys, discussing their foundation, lining, stability, and minor details. 3500 w. Engr, U S A—Feb. 1, 1907. No. 82100 C.

Concrete.

Concrete in Construction. Address by Edward T. Cairus before the Insurance Society of New York. Considers various processes of making and utilizing the material, with observations on fire tests of reinforced-concrete beams. 7400 w. Ins Engng—Feb., 1907. No. 82618 C.

Culvert.

A Novel Engineering Achievement—Burying a River to a Depth of 120 Feet. Illustrated description of the work of culverting the Ouseburn River, at Newcastle-on-Tyne, and filling the valley, to improve the connection with Heaton. 1200 w. Sci Am Sup—Feb. 9, 1907. No. 82179.

Dams.

The Cataract Dam, Sydney, New South Wales. Illustrated description of this masonry and concrete dam, constructed to supplement the storage of water for the city of Sydney. The total storage capacity is 21,411,500,000 gallons. 2000 w. Engng—Feb. 1, 1907. No. 82257 A.

A Remarkable Dam at Dellwood Park, Ill. Howard S. Knowlton. Rather unusual dam and bridge construction of reinforced concrete is illustrated and described. 700 w. Eng Rec—Feb. 9, 1907. No. 82228.

A Résumê of the Charles River Basin Project. Robert E. Barrett. Describes the construction of a roadway dam, architecturally beautiful, between the cities of Boston and Cambridge, forming a fresh water basin. Gives many illustrations. 2200 w. Harvard Engng Jour—Jan., 1907. No. 82619 D.

Failures.

See Reinforced Concrete.

Fireproofing.

Fire Protection Engineering. George Velten Steeb. Indicates the results already accomplished, showing how the work is being carried on. General discussion. 5000 w. Jour Assn of Engng Socs—Jan., 1907. No. 82496 C.

Floors.

Calculation of Reinforced Concrete Floors (Beitrag zur Berechnung der Hauptunterzüge von Eisenbeton-Balkendecken). S. C. Drach. Mathematical analysis of the stresses in concrete floors, longitudinally and transversely strengthened. Diagrams. 500 w. Zeitschr d Oest Ing u Arch Vereines—Jan. 4, 1907. No. 82334 D.

Foundations.

Foundation Problems in New York City. C. M. Ripley. Illustrates and describes the use of the air lock in sinking caissons to bedrock, and how the collapse of neighboring buildings is prevented. 1700 w. Ir Age—Feb. 14, 1907. No. 82264.

The Foundations of the Singer Building Extension, New York. An illustrated article describing the foundations for the tower 63 ft. square and a total height of over 612 ft. above the curb. 2200 w. Eng Rec—Feb. 2, 1907. No. 82105.

Piles.

Methods and Cost of Driving Raymond Concrete Piles for a Building Foundation. Gives figures of cost computed from records obtained in constructing the pile foundations for a building in Salem, Mass. 1000 w. Engng-Con—Feb. 13, 1907. No. 82219.

Experience with Steel Sheet Piling in Hard Soils. From a paper by William G. Fargo, read before the Michigan Engng. Soc., giving the writer's experience with this material. 1700 w. Eng Rec—Feb. 16, 1902. No. 82413.

Reconstruction.

A Piece of Reconstruction Work at Stanford University. Charles B. Wing. Brief illustrated description of the method used to restore the arcade arches distorted by the earthquake at Stanford University, to their original position, and of replacing the broken stones. 700 w. Cal Jour of Tech—Jan., 1907. No. 82050.

Reinforced Concrete.

An Eight-Story Reinforced Concrete Printing Building. Illustrated description of the building for the Ketterlinus Lithographic Manufacturing Co., in Philadelphia. 1700 w. Eng Rec—Feb. 2, 1907. No. 82108.

The Design and Construction of a Reinforced Concrete Apartment House. H. G. Perring. General remarks on this material, with illustrated description of a structure in Philadelphia. Discussion. 5000 w. Pro Engrs' Club of Phila—Jan., 1907. No. 82550 D.

Recent Failures of Reinforced Concrete. Louis H. Gibson. Remarks on the recent disasters at Long Beach, Cal., and at Rochester, N. Y., and the general reinforced concrete business. 2500 w. Munic Engng—Feb., 1907. No. 82276 C.

The Lesson of a "Concrete-Steel" Floor Failure. Gives facts relating to the collapse of a floor in England, discussing the cause of the failure. Ills. 2500 w. Builder—Feb. 16, 1907. No. 82585 A.

Failure of a 176 Ft. Reinforced-Concrete Chimney at Louisville, Ky. D. R. Lyman. An illustrated account of the failure of the chimney of the Seelbach Hotel, and report of the condition of the material, and the circumstances. 900 w. Eng News—Feb. 7, 1907. No. 82188.

Roads.

Mixing Rocks for the Wearing Surface of Macadam Roads. Notes from a report of the U. S. Office of Public Roads relating to the phenomena attending the decomposition of feldspars. 1800 w. Eng Rec—Feb. 23, 1907. No. 82525.

Shafts.

Sinking a Shaft with Steel and Concrete Lining in Soft Ground. W. E. Wagner. An interesting account of successful waterproofing under heavy pressure. The sinking of a shaft for a shot tower, at East Alton, Ill. 1800 w. Eng News—Feb. 21, 1907. No. 82530.

Sheet Metal.

How a Roofer Managed a Skylight Job. H. Tims Reilloch. The first of a series of illustrated articles on handling different kinds of sheet metal work. 1200 w. Met Work—Feb. 2, 1907. Serial. 1st part. No. 82056.

Stack.

Erecting an Extension to the Steel Smokestack of a Copper Smelting Plant. Drawings and information in regard to an interesting piece of work at Douglas, Ariz., where a new section of stack was erected on a framework, and moved onto the old stack. 900 w. Eng News—Feb. 7, 1907. No. 82189.

Tile.

Suggestions for Setting Tile. Karl Langenbeck. Suggestions for the tiling of walls and floors. Ills. 2500 w. Met Work—Feb. 16, 1907. No. 82297.

Tower.

The Steel Framework of the Metropolitan Tower. Illustrated detailed description of the steel work, for the tower of the Metropolitan Life Insurance Co.'s building in New York City. 3000 w. Eng Rec—Feb. 9, 1907. No. 82222.

Tunnels.

Method of Relining the Hodges' Pass Tunnel, Oregon Short Line Ry. An illustrated explanation of the methods of work adopted. 800 w. Engng Con—Feb. 20, 1907. No. 82477.

Methods and Cost of Constructing a Tunnel Through Clay by the Shield Method, Lawrence Ave. Intercepting Sewer, Chicago, Ill. 1800 w. Engng Con. —Feb. 6, 1907. No. 82160.

Waterproofing.

Waterproofing Concrete—The Elastic vs. the Rigid Method. Edw. W. De Knight. Considers the treating concrete to make it, in itself, impermeable and protecting concrete with something apart therefrom, to make it waterproof. 3300 w. Cement—Jan., 1907. No. 82279 C.

MATERIALS OF CONSTRUCTION.

Brick.

Strength of Brick and Brick Piers. James E. Howard. Read at convention of the Nat. Brick Mfrs. Assn. Gives results of tests made at the Watertown Arsenal. 2200 w. Eng Rec—Feb. 23, 1907. No. 82528.

Cement.

The Specific Gravity of Portland Cement. David Butler Butler. A report of results obtained by experimental investigations with a summary of the conclusions. 1000 w. Inst of Civ Engrs. Abstract of paper. No. 3625. No. 82035 N.

Solubility of Portland and Slag Cement (Ueber den Einfluss einiger Lösungen auf Portland und Schlackenzement). Heinrich Renezeder. Description of tests of mixtures of the two in different proportions. Ills. 1300 w. Oest Wochenschr f d Oeff Baudienst—Jan. 19, 1907. No. 82338 D.

Concrete.

Concrete Surface. Henry H. Quimby. Discusses tooling the surface, or the removal of the film and the exposure of the clean aggregate by any method, to give a pleasing surface. Also the effect of scrubbing the fresh surface with a brush and water. 2500 w. Cement—Jan., 1907. No. 82277 C.

Eucalyptus.

Eucalyptus as a Hardwood. O. M. Boyle, Jr. Information concerning this rapid growing timber and its value and uses. 3000 w. Cal Jour of Tech—Jan., 1907. No. 82051.

Gypsum.

Gypsum (Plaster of Paris) and Its Utilization. Trans. from Marco Pedrotti's "Der Gyps und Seine Verwendung." Gives early history of this material and the recent increase in the use. 2500 w. Sci Am Sup—Feb. 23, 1907. Serial. 1st part. No. 82578.

Iron and Steel.

On the Resistance of Iron and Steel to Reversals of Direct Stress. Thomas Ernest Stanton, and Leonard Bairstow. Describes experiments undertaken to ascertain the relative resistance of certain kinds of iron and steel in common use among engineers when subject to reversals of stress. Also investigations of the changes in structure of materials. Ills. Discussion. 2 plates. 19700 w. Inst of Civ Engrs—No. 3630. No. 82043 N.

Marbles.

I. Marbles: Their Ancient Application. Sir Lawrence Alma-Tadema. II. The Modern Aspect of Marble-Work in Architecture. William Brindley. Two papers, discussed together, and finely illustrated. 10000 w. Jour Roy Inst of Brit Archts. —Jan. 26, 1907. No. 82463 F.

Reinforced Concrete.

Economic Design of Reinforced Concrete. F. W. Hanna. Discusses the effect of the variable cost of steel and concrete on the economic working stress of the steel and the corresponding percentage of reinforcement. 1200 w. Eng News.—Feb. 21, 1907. No. 82531.

The Influence of a Few Local Economical Considerations on the Design and Execution of Reinforced Concrete Work. Rudolph B. Hartman. An illustrated article considering structural features of reinforced concrete work, materials and methods, and information needed by an engineer using this material. 8000 w. Wis Engr—Feb., 1907. No. 82617 D.

Mechanics of Reinforced Concrete. Prof. W. K. Hatt. A discussion of this material and the mechanical principles underlying the construction. 1800 w. Cement age—Feb., 1907. No. 82495.

Tests of Shear and of the Bond of Steel in Reinforced Concrete. Prof. A. N. Talbot. Results of tests made at the University of Illinois, to determine the unit values of shear in concrete and the bond between steel and concrete. 3000 w. Eng News—Feb. 14, 1907. No. 82292.

Timber.

Steel versus Wood. A comparison of the prices of steel beams and Southern pine, showing that for heavy loads steel is the cheaper. 1100 w. Ir Age—Feb. 14, 1907. No. 82262.

The Line of Advance in Wood Preservation. Carl G. Crawford. Read at meeting of Wood Preservers' Assn. A review of what has been accomplished, and especially recent improvements in processes, and the future outlook. 3500 w. Eng News—Feb. 7, 1907. No. 82187.

MEASUREMENT.

Deformations.

A Universal Instrument for Measuring Deformations of Materials. H. F. Moore. Illustrates and describes a self-indicating apparatus adapted to a large range of tests. 1200 w. Wis Engr—Feb., 1907. No. 82616 D.

MUNICIPAL.

Asphalt Plants.

The Design and Construction of Two Asphalt Mixing Plants. Illustrates and describes plants at Cincinnati and at Pittsburg, which have features of interest. From a paper by Charles Brossmann, Jr., before the Indiana Engng. Soc. 1600 w. Eng Rec—Feb. 9, 1907. No. 82224.

Combined Plant.

Electricity and Destructor Works. A. J. Abraham. Remarks on the success of combined plants for small towns, and their failure usually for towns of 40,000 or more inhabitants. 2000 w. Elec Rev, Lond—Feb. 1, 1907. No. 82246 A.

Pavements.

Granite-Top Macadam Paving in Oak Park, Ill. R. A. Carpenter. Abstract of a paper read before the Ill. Soc. of Engrs. & Survs. Reports the use of this pavement, calling attention to points to be observed in its construction in order to obtain the best results. 900 w. Eng News—Feb. 14, 1907. No. 82291.

Sewage.

New Electrically-Driven Sewage Pumping Plant at Salem, Mass. Illustrated description of interesting features in the new system for disposing of the sewage. 2000 Eng Rec—Feb. 23, 1907. No. 82527.

The Sewage Purification Problems, with Special Reference to Sewage Discharge into a Tidal Estuary. James D. Williamson, M. D. Deals with conditions at Belfast, and cities similarly situated, discussing the effect of sewerage discharged into tidal waters. General discussion. 8800 w. Jour Roy San Inst—Feb., 1907. No. 82288 B.

Sewage Filters.

The Maintenance of Sewage Filters in Winter. George E. Bolling. Gives experience with furrowed beds in winter at Brockton, and other information relating to the working of these filter-beds. General discussion. 7500 w. Jour Assn of Engng Socs—Jan., 1907. No. 82498 C.

Sewers.

Methods and Cost of Constructing a Large Reinforced Concrete Sewer at St. Louis, Mo. An unusual piece of sewer work is illustrated and described. The methods of construction and the cost are given. 900 w. Engng-Con—Feb. 20, 1907. No. 82476.

Sewer Construction in Holland (De Rioleering van S. Gravenhage). F. C. J. Van Der Steen Van Ommeren. Ills. Serial. 2 parts. 14000 w. De Ingenieur—Dec. 8 and 15, 1906. No. 82314 each D.

Sidewalks.

Cement Sidewalk Paving. Albert Moyer. Suggestions for the work in order to secure permanency, durability and neatness. Also specifications. 4800 w. Cement—Jan., 1907. No. 82278 C.

WATER SUPPLY.

Berlin.

Water Supply of Berlin (Die Wasserversorgung Berlins). Herr Anklam. Description of the supply and distributing system. Ills. 4200 w. Gesundheits Ingenieur—Jan. 26, 1907. No. 82352 D.

Filtration.

Different Methods of Purifying Water. P. A. Maignen. Gives much valuable information concerning processes of filtration, and chemical treatment, with illustrations. Discussion follows. 20500 w. Pro Engrs' Club of Phila—Jan., 1907. No. 82547 D.

The Filtration-Works for Supplying the Town of Alexandria with Potable Water. Henry Robert Cecil Blagden. Describes the first works of this kind in Egypt, this being the first town in Egypt to have an efficient filtration system. The Jewell system. 2 plates. Inst of Civ Engrs—No. 3615. No. 82038 N.

The Mechanical Filtration Plant at Wilmington, N. C. A. O. True. States the conditions of the water supply of this city, and gives an illustrated description of the filtration plant. 1800 w. Eng Rec—Feb. 9, 1907. No. 82226.

Theory of Artificial Biological Filters (Zur Theorie Künstlicher biologischer Filter). S. K. Dzierzgowsky. Tables, diagrams. Serial. 2 parts. 9300 w. Gesundheits Ingenieur—Jan. 5 and 12, 1907. No. 82306 each D.

Los Angeles.

Los Angeles Water Supply. Details of the proposed scheme to bring water 200 miles at a cost of over $24,400,000. Map. 2200 w. Engr, Lond—Feb. 8, 1907. No. 82471 A.

Marietta, Ga.

The Water-Works System and Electric Lighting Station at Marietta, Ga. Illustrated account of the reconstruction of the water-works system and electric power station to meet the increasing demands of service. 1800 w. Eng Rec—Feb. 23, 1907. No. 82522.

Sprinkler Systems.

Hazard of the Sprinkler Tank. J. E. Curtis. Discusses the erection and maintenance, the requirements for hoops, etc. 1500 w. Ins Engng—Jan., 1907. No. 82059 C.

The Care of Sprinkler Systems. Henry A. Fiske. Information concerning the proper maintenance of this protection, common faults that should be remedied, with suggestions relating to heads and valves. 4800 w. Ins Engng—Jan., 1907. No. 82058 C.

Stand-Pipe.

Reinforced Concrete Stand-Pipe at Attleboro, Mass. Illustrated detailed description of the construction of a structure 50 ft. in diameter and 106 ft. high. 2000 w. Eng News—Feb. 21, 1907. No. 82534.

Sterilization.

A Sterilized Water-Supply at Leavesden Asylum. William Thomas Hatch. Illustrates and describes the sterilizing apparatus, reporting tests made, coal consumed, and experiments in connection with the design of the apparatus. 3300 w. Inst of Civ Engrs—No. 3606. No. 82037 N.

Towers.

The Krestovsky Twin Water Towers at Moscow. Notes on the water system of Moscow, with illustrations of the twin towers and information of interest relating to them. 1200 w. Eng Rec—Feb. 2, 1907. No. 82107.

Wells.

Sinking a Flowing Well for the Water-Works of Salem, Va. J. N. Ambler. Describes the work of sinking, the difficulties and methods of overcoming them. 2500 w. Eng News—Feb. 7, 1907. No. 82186.

Sinking and Lining a 6-ft. Well 80-ft. Deep in Water-Bearing Soils. Information concerning work of excavating a well for a shot tower at East Alton, Ill., through sand, gravel and clay, which carried large quantities of water, and providing a perfectly waterproof concrete lining under very difficult conditions. 2000 w. Eng Rec—Feb. 16, 1907. No. 82414.

The Formation of a Concrete Well-Lining by Cement-Grouting Under Water. Robert William Vawdrey. Describes the method of carrying out this work, which illustrates one of the many uses to which Portland-cement grout may be applied. 2000 w. Inst of Civ Engrs—No. 3616. No. 82036 N.

WATERWAYS AND HARBORS.

Brussels.

Water Front Improvements at Brussels (Les Nouvelles Installations Du Port De Bruxelles). J. M. Roux. Description of bridges, canal improvements, etc. Ills. 4200 w. Le Génie Civil—Jan. 12, 1907. No. 82323 D.

Canals.

Mechanical Canal Locks in Canada. Walter J. Francis. An illustrated detailed description of the Canadian hydraulic locks on the Trent Canal. 7000 w. Can Soc of Civ Engrs—1906. No. 82053 N.

The Canal System of Canada. Maps and description of the canals through Canada from tidewater to the Great Lakes, and also the branches; calls attention to improvements needed to accommodate the large vessels, and the canals under construction to connect Lakes Huron and Ontario. 2200 w. R R Gaz—Feb. 15, 1907. No. 82404.

The Chesapeake and Delaware Canal. Lewis M. Haupt. An introductory statement of present conditions causing congestion of traffic, urging the improvement of waterways as a remedy, and giving arguments of the Trades League of Philadelphia in favor of the construction of the Chesapeake and Delaware Canal. Ills. 5000 w. Jour Fr Inst—Feb., 1907. No. 82060 D.

Colorado River.

Notes on Closing the Break in the Colorado River. Illustrates phases of this difficult work, giving explanatory notes. Also editorial comment and discussion of the disaster and the methods to effect a closure. 2800 w. Eng News—Feb. 21, 1907. No. 82535.

Closing Latest Break of the Colorado

River into the Salton Sea. Gives a map showing the latest break of the Colorado River, and an illustrated description of the methods of overcoming the difficulty. This break was closed Feb. 11, at 6 P. M. 800 w. R R Gaz—Feb. 15, 1907. No. 82405.

The New Inland Sea. Arthur P. Davis. Describes the Colorado River and the irrigation projects for utilizing its waters, especially the disaster which turned the waters mainly into the Salton Sea, and the desperate attempts to regain control of the river. Ills. 4500 w. Nat Geog Mag—Jan., 1907. No. 82047 C.

Docks.

The New Naval Docks at Davenport. An illustrated detailed description of this extensive addition to the naval resources of Great Britain. 7800 w. Plates. Engng—Feb. 15, 1907. Serial. 1st part. No. 82606 A.

Drainage.

Drainage Canal at Hertogenbosch, Holland (Het afwateringskanaal van 's Hertogenbosch naar Drongelen). J. P. Wijtenhorst. Ills. 3600 w. De Ingenieur—Dec. 29, 1906. No. 82315 D.

Dredge.

A Powerful Dredge Equipped with a Cable Storage Drum. Illustrates and describes the dredge "Majestic," in use on the St. Mary's River improvement, Michigan. 1600 w. Eng News—Feb. 7, 1907. No. 82183.

Harbors.

The Harbors of South Africa; with Special Reference to the Causes and Treatment of Sand-Bars. Cathcart William Methven. Information concerning the harbors on the Southeast African coast. Considers principally the physical features affecting these harbors, and some of the problems that arise in dealing with bars on this sandy coast. Also discussion. Ills. 29500 w. Inst of Civ Engrs—No. 3602. No. 82042 N.

The Modern Development of British Fishery Harbors. H. C. M. Austen. Discusses the importance to the United Kingdom, of the fishery harbors and the causes of their modern extension; the effect of the change in the character of the fishing vessels, and the engineering aspects of the subject generally. Map. 3300 w. Engng—Feb. 8, 1907. Serial. 1st part. No. 82465 A.

The Midland Railway Company's Harbor at Heysham, Lancashire. George Neill Abernethy. A detailed description of the construction and equipment of this harbor, designed to provide increased accommodation for traffic to Ireland, and the Isle-of-Man. Plate. 4000 w. Inst of Civ Engrs—No. 3635. No. 82040 N.

Ohio River.

Government Improvement of the Ohio River from End to End. One of the Most Important Undertakings Now Before Congress. Remarks on the importance of this work and the cause of the delay, describing the location of the river and the many manufactures carried on along its banks. 2500 w. Naut Gaz—Feb. 14, 1907. No. 82425.

Panama.

Isthmian Canal. C. L. Chester. An outline of the points connected with the Panama Canal. General Discussion. 5500 w. Pro N Y R R Club—Jan. 18, 1907. No. 82269.

Progress on the Panama Canal. Fullerton L. Waldo. An illustrated account of things observed during a visit in Dec., 1906. 4000 w. Cassier's Mag—Feb., 1907. No. 82281 B.

The Panama Canal—The "Lock Canal" Type and the "Straits of Panama" Type. Phillippe Bunau-Varilla. An illustrated article discussing the system of construction, the lock canal, past and present works and projects, with related matters. General discussion follows. 21500 w. Jour Soc of Arts—Jan. 25, 1907. No. 82289 A.

Sea Coast.

Repairing Damage Resulting from the Storm of March 12, 1906, on the Coast of Zeeland (Over eenige verchijnselen waargenomen in Zeeland bij den stormvloed van 12 Maart 1906). R. L. R. de Muralt. Ills. 3300 w. De Ingenieur—Dec. 22, 1906. No. 82302 D.

Teredo.

The Teredo in South Africa. Data concerning the methods used to meet the difficulty, due to ravages of the teredo, along the coast. Also discussion. 5000 w. R R Gaz—Feb. 1, 1907. No. 82082.

MISCELLANY.

Caisson Disease.

Compressed Air Illness or Caisson Disease. Abstract translation of a lecture by Thomas Oliver, giving a physiological and clinical study of the effects of work in compressed air. 3000 w. Compressed Air—Feb., 1907. No. 82494.

Salaries.

The Compensation of Engineers. J. D. Blackwell. Abstract of Presidential address before the Pacific Soc. of Eng. 1000 w. Eng News—Feb. 7, 1907. No. 82399.

Stresses.

Further Note on Summation of Stresses in Certain Structures. John C. Trautwine, Jr. Briefly reviews arguments in a paper by Mr. Carl Hering on this subject, and gives an elaboration leading to a more complete generalization. Discussion. 6500 w. Pro Engrs' Club of Phila—Jan., 1907. No. 82551 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

The First Atlantic Cable. John Mullaly. An account of the first Atlantic telegraph expeditions from the pen of an eye-witness, who was personally connected with the work. 2500 w. Jour Fr Inst—Feb., 1907. Serial. 1st part. No. 82063 D.

Microphone.

A New Compensating Microphone. Illustrates and describes the construction and states the advantages claimed. 1800 w. Elec Engr, Lond—Feb. 1, 1907. No. 82241 A.

Radio-Telegraphy.

Portable Wireless Outfits for U. S. Signal Corps. C. H. Cloudy. Illustrated detailed description of a field wireless set. 800 w. Elec Wld—Feb. 16, 1907. No. 82432.

Radio-Telegraph Installation for Signalling Across the Wash. Illustrates and describes an installation for signalling over a distance of 16 miles across the Wash, between Hunstanton and Skegners. 1200 w. Elec Rev, Lond—Feb. 8, 1907. No. 82455 A.

The Making and Using of a Wireless Telegraph Tuning Device. A. Frederick Collins. The fourth of a series of articles dealing with a 100-mile wireless telegraph set. Ills. 1600 w. Sci Am Sup—Feb. 16, 1907. No. 82424.

The Installation and Adjustment of a 100-Mile Wireless Telegraph Set. A. Frederick Collins. The third of a series of articles on related topics. Describes the installation, giving plan of arrangement of apparatus. Ills. 2200 w. Sci Am Sup—Feb. 9, 1907. No. 82178.

The Location and Erection of a 100-Mile Wireless Telegraph Station. A. Frederick Collins. Gives data relating to the location and erection of a station, using the instruments described in an earlier article. Ills. 2500 w. Sci Am Sup—Feb. 2, 1907. No. 82088.

The Theory and Action of a 100-Mile Wireless Telegraph Set. A. Frederick Collins. The fifth of a series of related articles explaining the theory and working of the instruments employed. Diagrams. 2500 w. Sci Am Sup—Feb. 23, 1907. No. 82583.

Trans-Atlantic Wireless Telegraphy. Illustrates and describes the construction of the tower at Machrihanish, N. B., for Trans-Atlantic service. This tower was blown down by a storm and the cause of the disaster is explained and details described. 1600 w. Engng—Jan. 25, 1907. No. 82153 A.

Radio Telephony.

Wireless Telephony. R. A. Fessenden. Briefly discusses the present status, and future prospects, and begins a review of the developments. Ills. 2000 w. Elec Rev, Lond—Feb. 15, 1907. Serial. 1st part. No. 82600 A.

The Continuous Production of High-Frequency Oscillations. R. A. Fessenden. Gives a short historical résumé dealing principally with arc methods used by the writer for producing high-frequency oscillations, and their application to wireless telephony. 2800 w. Elect'n, Lond—Feb. 15, 1907. Serial. 1st part. No. 82603 A.

Relays.

Telephonic Relays (Le Relais Téléphonique). —— Henry. Review of the different types now in use. Ills. 3800 w. L'Electricien—Jan. 19, 1907. No. 82347 D.

Telegraphy.

Pollak and Virag Rapid Telegraph System (Télégraphe Rapide Système Pollak et Virag). M. D. Korda. Comprehensive description of this device and the results achieved with it. Ills. 4200 w. Bulletin De La Société Internationale Des Electriciens—No. 60. Dec., 1906. No. 82317 F.

Telephony.

Poulsen's Telephonic Message Recorder. Illustrates and describes this invention by means of which telephonic messages may be recorded or stored. 1000 w. Sci Am Sup—Feb. 23, 1907. No. 82582.

Central Battery Installations for Telephone Stations (Betrachtungen über Zentralbatterie-Schaltungen für Fernsprech-Amter). E. Neuhold. Arrangement of circuits described. Diagrams. 1700 w. Elektrotech Zeitschr—Jan. 24, 1907. No. 82353 B.

Some Phases of Telephone Manufacture. G. S. Macomber. Outlines the history of the rapid growth of the telephone industry, and the organization of the manufacturing company to obtain the highest efficiency, reviewing the operations required to produce the apparatus. Ills. 5000 w. Sib Jour of Engng—Feb., 1907. No. 82500 C.

Widening Applications of the Telephone. William Maver, Jr. An illustrated article calling attention to recent extension in the use of the telephone. 2000 w. Cassier's Mag—Feb., 1907. No. 82280 B.

The Application of the Telephone to Railway Service. C. J. H. Woodbury.

Abstract of a paper read before the New England St. Ry. Club. Brief account of some of the uses made of the telephone for railway service and the composite systems, making possible the use of the same wires for the telegraph and telephone. 2200 w. Elec Rev, N Y—Feb. 23, 1907. No. 82557.

Telephotography.

Korn's Photographic Fac-Simile Telegraph. Information concerning one of the latest systems of reproducing photographic images at a distance by means of electricity. Ills. 1200 w. Sci Am—Feb. 16, 1907. No. 82421.

DISTRIBUTION.

Converters.

The Peebles-Bragstad-LaCour Converters. Illustrated detailed description. 1200 w. Elec Engr, Lond—Jan. 25, 1907. No. 82139 A.

Switchboard.

New Switchboard in the Hanoverian Technical High School (Die neue Haupt-Schaltanlage im Elektrotechnischen institute der Technichen Hochschule Hannover). E. Beckmann. Ills., diagrams. 1700 w. Elektrotech Zeitschr—Jan. 10, 1907. No. 82330 B.

Transformation.

The Transformation of Electrical Energy. C. Francis Harding. Considers in detail the direct and alternating current transformations which are necessary that the electrical energy may be distributed over a broad area in small units for varying uses. 3000 w. Sib Jour of Engng—Feb., 1907. No. 82499 C.

Three-Phase Transformation. A. S. McAllister. Discusses the relative merits of the three-phase transformer and the combination of single-phase transformers that may be employed for the same service. Also editorial. 2500 w. Elec Wld—Feb. 9, 1907. No. 82199.

Practical Notes on Transformer Testing. Ernest A. Reid. Read before the Dick-Kerr Engng. Soc. Describes the tests made by the makers before they leave the shop. 2500 w. Elec Engr, Lond—Feb. 1, 1907. No. 82242 A.

Upper Savoy.

Distribution of Electric Energy in Upper Savoy (Les Distributions D'Energie Electrique dans la Haute-Savoie). J. A. Montpellier. Description of generating and distributing plants. Map. 3600 w. L'Electricien—Jan. 26, 1907. No. 82348 D.

Distribution of Electric Energy in Savoy (Les Distributions D'Energie Electrique dans La Savoie). J. A. Montpellier. Description of the generating and distributing plants throughout the province of Savoy. Ills. 5300 w. Serial. 2 parts. L'Electricien—Jan. 5 and 12, 1907. No. 82345 D.

Wiring.

Wiring a Frame Dwelling with Flexible Metallic Conduit. Thomas W. Poppe. Suggestions, with illustrations, for an installation of flexible tubing. 1500 w. Elec Wld—Feb. 2, 1907. No. 82132.

ELECTRO-CHEMISTRY.

Caustic Soda.

McDonald Electrolytic Bleach and Caustic Soda Plant. J. R. Crocker. Illustrates and describes a plant installed at Johnsonburg, Pa., which has been in operation over a year. 700 w. Elec-Chem & Met Ind—Feb., 1907. No. 82201 C.

Electroplating.

Producing Rose-Gold Deposits. Explains the essential features for obtaining a good rose-gold deposit. 1000 w. Brass Wld—Feb., 1907. No. 82553.

Some Points on the Plating Barrel. An illustrated article giving suggestions in regard to running the plating machine. 1000 w. Brass Wld—Feb., 1907. No. 82554.

Insulating Films.

An Optical Study of the Thin Film Deposited by Electrolysis on an Aluminium Anode. O. M. Carbino. Abstract translation from *Il Nuovo Cimento.* Describes measurements by optical methods of the thickness of these films. 800 w. Elect'n, Lond—Jan. 25, 1907. No. 82146 A.

Nitrates.

The Artificial Production of Nitrates from the Atmosphere. J. B. Van Brussel. An illustrated description of the Birkeland and Eyde process for the production of nitric oxide. 1500 w. Eng News—Feb. 7, 1907. No. 82185.

Fixation of Nitrogen of the Air (Uber Fixierung des Stickstoffs der Luft und Verwendung der gewonnenen Körper). G. Erlwein. Ills. Serial. 2 parts. 4800 w. Elektrotech Zeitschr—Jan. 10 and 17, 1907. No. 82340 B.

Review, 1906.

The Electro-Chemical and Electro-Metallurgical Industries in 1906. John B. C. Kershaw. Gives details of the position of the various industries, the most progress having been made in the copper, iron, steel, and nitrogen industries. 3000 w. Elect'n, Lond—Feb. 8, 1907. No. 82458 A.

ELECTRO-PHYSICS.

Induction Coils.

The Construction of Induction Coils. William O. Eddy. Treats of some of the theoretical considerations and the technical designs of induction coils, dealing with methods of practical construction and the more important manufacturing details. 2000 w. Elec Wld—Feb. 2, 1907. No. 82131.

Polyphase.

The Calculation of Polyphase and Single-Phase Windings by Vector Diagram (Die Berechnung der Emk von Mehrphasen und Einphasen Wicklungen auf Grund eines Vektor diagrammes der Feldstärke). H. Görges. Extended mathematical treatment. Diagrams. 2900 w. Elektrotech Zeitschr—Jan. 3, 1907. No. 82328 B.

Rheostats.

Notes on Rheostat Design. F. D. Hallock. Considers points of interest in the design of rheostats employed in series circuits, and in shunt circuits. 2000 w. Elec Jour—Feb., 1907. No. 82492.

Sparking.

Calculation of Dynamo Sparking Characteristics. Carlton L. Kennedy. Discusses the determining of the limiting commutating current from the standpoint of reactance voltage, also considering the effect of armature current, and the influence of a displacement of the brushes. 2400 w. Elec Wld—Feb. 16, 1907. No. 82431.

Transformer.

Resonance Transformer (Der Resonanz Transformator). Gustav Benischke. Mathematical paper. Diagrams. 1300 w. Elektrotech Zeitschr—Jan. 10, 1907. No. 82329 B.

Wave Distortion.

Effect of Iron in Distorting Alternating-Current Wave-Form. C. P. Steinmetz. Deals with a paper by Messrs. Bedell & Tuttle, read before the Am. Inst. of Elec. Engrs., in which the writers discussed the relation between the harmonics introduced by iron into the alternating-current wave and the hysteresis loop of the iron to which these harmonics were due. 3800 w. Elect'n, Lond—Jan. 25, 1907. No. 82148 A.

GENERATING STATIONS.

Alternators.

Self-Regulating Alternator with Auxiliary Field. A. Heyland. Illustrated description of an innovation aiming to counteract the demagnetizing action of the armature magnetomotive force of the load current on the magnetic field of the machine, and on the fall of potential. 2000 w. Elec Wld—Feb. 23, 1907. No. 82542.

Alternators with Auxiliary Regulating Field. A. Heyland. Gives a summary of a previous article on this subject, in which the theory of this new method of compensating and compounding alternators was developed, and shows how to determine the necessary alterations for any given alternator. Ills. 4000 w. Elect'n, Lond—Feb. 8, 1907. Serial. 1st part. No. 82457 A.

Instructions for Installing and Operating Alternating-Current Generators. Instructions taken from a book prepared by the Allis-Chalmers Company for the use of its customers. Ills. 2500 w. Elec Rev, N Y—Feb. 2, 1907. No. 82104.

Breakdowns.

On the Prevention of Breakdowns in Central Stations. An explanation of methods used by the writer for keeping the number of interferences with the supply of electricity down to the minimum. 2500 w. Elec Rev, Lond—Feb. 8, 1907. No. 82454 A.

Condensers.

High-Voltage Condensers. C. L. Durand. Explains the advantages of the use of condensers, their applications and features. Ills. 1500 w. Elec Rev, N Y—Feb. 16, 1907. No. 82407.

Hydro-Electric.

Recent Hydraulic Power Developments in Switzerland. Enrico Bignami. Illustrates and describes recent hydro-electric installations designed to utilize the power of the River Orbe, which forms the outlet of the lakes of Joux. 2000 w. Cassier's Mag—Feb., 1907. No. 82284 B.

Electric Power Canal at Lake Constance (Les Usines Electriques Du Canal De Derivation du Rhin en amont du lac de Constance). S. Herzog. Description of water power plants deriving energy from the Rhine between Austria and Switzerland. Ills. 1400 w. Le Génie Civil—Jan. 5, 1907. No. 82325 D.

The Ticino River Hydro-Electric Plants in Italy. Frank C. Perkins. Illustrated descriptions of an interesting modern installation using the latest methods. 1700 w. Elec Engr, Lond—Jan. 25, 1907. No. 82138 A.

The Hydro-Electric Plant of the Utica Gas and Electric Company. Illustrated description of this plant in central New York, and its wooden stave pipe line. 900 w. Elec Rev, N Y—Feb. 23, 1907. No. 82556.

The St. Louis River Hydro-Electric Plant. Describes a plant under construction in Minnesota to furnish power for working the iron mines in the Missabe range, at 70 miles distance, and to furnish current for light and power to Duluth and also to St. Paul and Minneapolis, 125 miles distant. 2000 w. Engr, Lond—Feb. 15, 1907. No. 82611 A.

Municipal Plant.

South Norwalk Municipal Electric Works. Illustrated description of a successful plant in Connecticut which furnishes power for street and commercial lighting. 2000 w. Munic Jour & Engr—Feb. 6, 1907. No. 82171 C.

Trezzo D'Adda.

The Trezzo D'Adda Electric Power

Station. Illustrated description of this Italian station and its equipment. 1600 w. Engng—Feb. 8, 1907. No. 82466 A.

LIGHTING.

Arc Lamps.

The Magnetite Arc Lamp. J. S. R. Hyden. Illustrates and describes this improvement on the carbon lamp, explaining the mechanism. 1200 w. Cassier's Mag—Feb., 1907. No. 82283 B.

Long Flame and Chemical Arcs. W. R. Ridings. Read before the British Westinghouse Engrs. Club. Considers the history and development of the flame arc lamp, and the efficiency and advantages of the flame arc lamp over the pure carbon type. 2000 w. Elec Engr, Lond—Feb. 8. 1907. No. 82453 A.

Illumination.

Lighting of the State Capitol at Harrisburg, Pa. An illustrated article describing this beautiful State building, and the arrangements for artificial lighting by electricity. 3500 w. Elec Wld—Feb. 2, 1907. No. 82129.

Incandescent Lamps.

Investigations on Light Standards and the Present Condition of the High-Voltage Glow Lamp. Clifford C. Paterson. An illustrated account of tests, made at the National Physical Laboratory, giving facts of value to the electrical and gas industries. Deals with flame standards and other tests. 12600 w. Inst of Elec Engrs—Jan. 24, 1907. No. 82057 N.

Investigations on Light Standards and the Present Condition of the High- Voltage Glow Lamp. Clifford C. Patterson. Abstract of a paper read before tne Inst. of Elec. Engrs. An account of investigations carried out at the National Physical Laboratory. The first part deals with the standards of light; the second part with commercial glow-lamp testing. 5500 w. Elect'n, Lond—Jan. 25, 1907. Serial. 1st part. No. 82145 A.

The Standard Specification for Carbon Glow Lamps: A Criticism. Lancelot W. Wild. A criticism of tests proposed, with suggestions. 1600 w. Elec Rev, Lond—Feb. 15, 1907. No. 82602 A.

Ratio of the Carcel, Hefner and Vernon-Harcourt Standards of Light (Etude Sur Le Rapport Des Trois Lampes Carcel, Hefner et Vernon-Harcourt). Laporte and Jouaust. Relative luminosity of these standards discussed on the basis of results obtained by various investigators. 3300 w. Bulletin De La Société Internationale Des Electriciens—No. 58, Oct., 1906. No. 82316 F.

Comparative Life Tests on Carbon, Nernst, and Tantalum Incandescent Lamps Using Alternating Currents. H. F. Haworth, T. H. Matthewman, and D. H. Ogley. Tests made to determine whether the working of such lamps was in any degree different with alternating-current than when using continuous current. Ills. 4500 w. Inst of Elec Engrs—Feb. 7, 1907. No. 82615 N.

Modern Types of Electric Lamps (Modern Elektrische Lichtbronnen). E. J. F. Thierens. Comparison of principal lamps now in use. 5400 w. De Ingenieur—Jan. 12, 1907. No. 82337 D.

Mirrors.

Parabolic Mirrors for Incandescent Lamps (Parabolspiegel mit elektrischem Glühlicht). Georg König. Discussion of advantages gained by use of mirrors for incandescents and for Nernst lamps. Diagrams. 4200 w. Elektrotech Zeitschr—Jan. 17, 1907. No. 82331 B.

MEASUREMENT.

Cables.

On the Effective Capacities of Cables and Their Determination by the Ballistic Method. W. Akemann. Abstract translation from *Elektrotechnische Zeitschrift.* Defines the effective capacity of any conductor of a multi-core cable, and shows how to determine it by the ballistic method, the investigation being extended to cables with pilot wires. 800 w. Elect'n, Lond—Feb. 8, 1907. No. 82460 A.

The Effective Capacity of Large Current Cables, and Their Measurement with Direct Current (Uber die wirksame Kapazität von Starkstromkabëln und ihre einheitliche Messung mit Gleichstrom). W. Akemann. Mathematical treatment. Diagrams. 1800 w. Elektrotech Zeitschr—Jan. 3, 1907. No. 82327 B.

Galvanometer.

A New Type of Alternating-Current Galvanometer of High Sensibility. W. S. Franklin and L. A. Freudenberger. From the *Physical Review.* Illustrates and describes a Kelvin astatic galvanometer modified so as to be suitable for alternating currents. 1200 w. Elect'n, Lond—Feb. 8, 1907. No. 82461 A.

Hysteresis.

Measurement of the Hysteretic Loss at Slow Cycles. Dr. Gisbert Kapp. Describes a method that can be carried out by one observer, for which no special apparatus is needed. 600 w. Elec Engr, Lond—Feb. 15, 1907. No. 82598 A.

Meters.

A New Form of Induction Ammeter or Voltmeter. Paul MacGahan. Describes the induction principle as applied to the modern Westinghouse alternating-current type of meters. Ills. 9000 w. Elec Jour—Feb., 1907. No. 82493.

Polyphase Metering Conventions. M. C. Rypinski. Outlines briefly some features of the Westinghouse apparatus. Ills. 600 w. Elec Jour—Feb., 1907. No. 82491.

Warrantable Expense for Meter Testing. Oliver J. Bushnell. Read before the N.-W. Elec. Assn. Gives a brief study of conditions affecting meter accuracy, discussing methods used, and related facts, with cost. 4200 w. Elec Rev, N Y —Feb. 9, 1907. No. 82220.

Photometers.

The Theory of Flicker Photometers. J. S. Dow. Considers some of the chief points arising in the design and use of such instruments. 2200 w. Elect'n, Lond —Feb. 1, 1907. Serial. 1st part. No. 82248 A.

Reactance Voltage.

Graphical Diagram for Determining the Reactance in Alternating Current Circuits. T. W. Varley. Gives a diagram, equivalent to a straight line plotted from rectangular logarithmic co-ordinates, illustrating its use by an example. 600 w. Elec Wld. Feb. 9, 1907. No. 82198.

Resistivity.

Resistivity-Temperature Formulæ for Copper. Dr. F. B. Crocker. Shows that there is considerable difference of usage among electrical engineers. 1500 w. Elec Wld—Feb. 23, 1907. No. 82541.

Three Phase.

Measurement of Power in Three-Phase Systems (Notiz über die Leistungsmessung in Drehstrom-Systemen mit Nulleiter). E. Orlich. Mathematical discussion. 500 w. Elektrotech Zeitschr—Jan. 24, 1907. No. 82341 B.

Measurement of Power in Three-Phase Circuits (Leistungsmessungen bei Drehstrom). F. E. Mathematical paper. Diagrams. 1600 w. Elektrotechnik und Maschinenbau—Jan 6, 1907. No. 82300 D.

MOTORS.

Single-Phase.

Single-Phase Motors. H. R. Speyer. Considers briefly the induction motor and the series repulsion motor, and motors combining the two types and their characteristics. Ills. 2500 w. Elec Engr, Lond—Feb. 1, 1907. Serial. 1st part. No. 82240 A.

Starter.

New Motor Starter. Brief illustrated description of the "helical drum starter" which is essentially different from any in present use. 1000 w. Elec Rev, Lond —Feb. 15, 1907. No. 82601 A.

Windings.

Series vs. Parallel Windings in Alternating-Current Motors. R. E. Hellmund. Gives a comparison between parallel and series connections. 1200 w. Elec Wld— Feb. 23, 1907. No. 82543.

TRANSMISSION.

Wire.

Hard-Drawn Copper Wire. Thomas Bolton. Gives an account of results obtained in a number of tests recently carried out, to acquire data which might assist toward the framing of standard specifications for all sizes of wire. 1800 w. Elec Rev, Lond—Jan. 25, 1907. No. 82141 A.

Specifications for Line Wire. F. F. Fowle. Views based on experience of a telephone engineer. General discussion also. 6800 w. Pro Ry Sig Assn—1906. No. 82479 N.

MISCELLANY.

Coal-Tipping.

A Novel German Electric Coal-Tipping Device. Frank C. Perkins. Illustrations, with brief description. 400 w. Sci Am Sup—Feb. 2, 1907. No. 82087.

Electric Applications.

Applications of Electricity in the Mess Hall at West Point, N. Y. Illustrates and describes many and varied uses of electricity. 1500 w. Elec Wld—Feb. 23, 1907. No. 82540.

The Field of Electric Alternating-Current Service. H. S. Knowlton. Discusses the special field of usefulness of alternating-current service, with particular reference to the use of the single-phase electric motor. 1800 w. Cassier's Mag—Feb., 1907. No. 82287 B.

The American Co-operative Electrical Development Association. R. Borlase Matthews. An explanation of the object and work of this association for the promotion of the use of electricity for light, heat and power. 3000 w. Elec Rev, Lond—Feb. 8, 1907. No. 82456 A.

Electric Heating.

Electric Heating and Its Application to the Fusion and Firing of Refractory Materials. R. S. Hutton. Gives an account of some advances being made in the application of electric heating, such as laboratory and experimental uses and industrial processes. 3000 w. Elec Rev, N Y—Feb. 23, 1907. No. 82558.

Electric Heating and Its Application to the Fusion and Firing of Refractory Materials. R. S. Hutton. Abstract of a paper read before the English Ceramic Soc. Divides the paper into laboratory applications and industrial processes. Describes different types of furnaces for laboratory use, and gives details of the manufacture of carborundum, and other refractory materials. 2000 w. Elect'n, Lond —Jan. 25, 1907. No. 82140 A.

Exposition.

Electric Power Exhibits at Milan Exposition (Die Elektrotechnik auf der internationalen Ausstellung in Mailand). Alfred Grünhut. Description of motors and controllers for traction and stationary purposes. Ills. Serial. 2 parts. 7700 w. Elektrotech und Maschinenbau—Jan. 20 and 27, 1907. No. 82335 D.

London.

Electric Power Supply in London. R. L. Pearson. Information relating to this subject, describing in detail some of the extensions of plant recently made and giving a résumé of the earlier features of the undertakings, showing progress of electrical energy supply for power purposes. Ills. 2000 w. Elect'n, Lond—Feb. 1, 1907. Serial. 1st part. No. 82247 A.

Progress.

The Progress of Electrical Science in 1906. E. E. Fournier d' Albe. An interesting review. 2800 w. Elect'n, Lond—Jan. 25, 1907. No. 82147 A.

INDUSTRIAL ECONOMY

Apprenticeship.

Apprenticeship. James Parsons. An account of the objects and work of an Apprenticeship and Skilled Employment Committee, with comments. 11000 w. Jour Soc of Arts—Feb. 1, 1907. No. 82230 A.

Channel Tunnel.

The Channel Tunnel. Walter H. James. Discusses both the military and commercial sides of the question, presenting arguments unfavorable to the construction. 4500 w. Contemporary Rev—Feb., 1907. No. 82488 D.

The Revived Channel Tunnel Project. Gives 6 short articles by prominent men of England protesting against the connection of England and France by a tunnel under the Channel. Also a reprint of a protest published in 1883. 65000 w. Nineteenth Cent—Feb., 1907. No. 82487 D.

Cost Systems.

Labor: Individual Shop Orders and Groups of Orders. F. E. Webner. Sixth of a series of articles on cost keeping. Discusses the utilization of scrap or waste stock, and matters relating to shop orders. 1200 w. Ir Trd Rev—Feb. 7, 1907. No. 82182.

Cost Reduction Through Cost Comparison. C. E. Knoeppel. The present paper refers only to burden costs. Explains a system devised by the writer, illustrating by an example. 2500 w. Engineering Magazine—March, 1907. No. 82639 B.

Education.

Technical Education of Apprentices in Connection with Actual Practice. S. M. Dolan. Deals particularly with the supplementary education of railroad apprentices, showing what has been done at the Missouri Pacific Ry. shops at Sedalia, Mo. Ills. 2700 w. Pro St Louis Ry Club—Jan. 11, 1907. No. 82266.

The Weak Point in Our Systems of Industrial Education. H. F. J. Porter. Discussion of the A. S. M. E. paper, "A Plan to Provide for a Supply of Skilled Workmen," by M. A. Alexander. 2200 w. Am Mach. Vol 30. No. 6. No. 82170.

Engineering School.

The United States Naval Academy as an Engineering School. Walter F. Worthington, Commander, U. S. N. An illustrated article giving information in regard to the training for naval officers at Annapolis in engineering, and the writer's conclusions concerning its value. 2500 w. Engineering Magazine—March, 1907. No. 82633 B.

Iron Industry.

The Mechanical Development of the German Iron Industry. J. H. Cuntz. An illustrated review discussing the importance of by-product coking, the utilization of furnace gases, and advanced practice in electric driving, as factors affecting the economy in the German iron industry. 3300 w. Engineering Magazine—March, 1907. No. 82637 B.

Labor.

A Plan to Provide a Supply of Skilled Workmen. Discussion of paper by M. W. Alexander. 4000 w. Pro Am Soc of Mech Engrs—Feb., 1907. No. 82502 F.

Insurance of Labor in Italy. Editorial on the Italian law which deals with the compensation to workmen for accidents, and some of the frauds perpetrated, with an explanation of the National Provident Fund. 2300 w. Engng—Feb. 1, 1907. No. 82296 A.

Management.

Profit Making in Shop and Factory Management. C. U. Carpenter. This third article of a series on the application of the "Committee System of Management," deals with the drafting-room and the tool-room, and the requirements for efficient work. 4500 w. Engineering Magazine—March, 1907. No. 82640 B.

Patents.

The Cost of a Golden Age. A. S. Fitch. Remarks on the achievements of the past half century in the line of important inventions, showing the debit side of the patent account. 2800 w. Am Mach—Vol. 30, No. 6. No. 82166.

Safety Devices.

First International Exposition of Safety Devices and Industrial Hygiene. An account of the exhibition at the American Museum of Natural History, New York City, of safety devices for the prevention of accidents to workmen. Also editorial.

4500 w. Eng News—Feb. 14, 1907. No. 82295.

Testing.

The National Physical Laboratory as a Commercial Testing Establishment. Reprint articles bearing upon the policy of the National Physical Laboratory of England, with criticism. 5400 w. Engr, Lond—Feb. 15, 1907. No. 82610 A.

Trade Secrets.

The Ethics of Trade Secrets. Frederick P. Fish. Remarks on the part trade secrets have played in the industries of the past, and the present laws for the protection of such information, giving test cases, and showing their justice. 12800 w. Pro Am Soc of Mech Engrs—Feb., 1907. No. 82501 F.

Tyneside.

Tyneside Industrial Progress and Prospects. A review of the industrial situation and economic conditions of this district and its suitability for new works; its industrial progress and prospects. Map. 5000 w. Engng—Feb. 1, 1907. Serial. 1st part. No. 82252 A.

MARINE AND NAVAL ENGINEERING

Battleships.

The Battleship of the Future. Forrest E. Cardullo. A discussion of the "Dreadnought," and the general lines along which battleship design may be expected to progress. Ills. 3000 w. Sci Am—Feb. 9, 1907. Serial. 1st part. No. 82177.

Notes on the Development of Warship Design. R. H. M. Robinson. Read before the Soc. of Nav. Archts. & Marine Engrs. Discusses points in the development, construction and equipment of warships. 9000 w. Marine Rev—Jan 31, 1907. No. 82099.

Coaling.

The "Express" Coal-Bagging Lighter for Coaling War Vessels in Harbor. Illustrates and describes a new type of coal-bagging lighter being tried by the British naval authorities. 2000 w. Sci Am—Feb. 2, 1907. No. 82083.

Cruiser.

The Peruvian Cruiser Coronel Bolognesi. Illustrated description. 800 w. Engr, Lond—Feb. 1, 1907. No. 82261 A.

The Steam Trials of the Armored Cruiser "Warrior." Illustrates the four-cylinder triple-expansion engines, reporting the successful trials, and giving general information. 800 w. Engng—Feb. 8 1907. No. 82468 A.

Destroyers.

New Italian Torpedo-Boat Destroyers. Illustrates and describes recent boats of this class. 700 w. Naut Gaz—Feb. 14, 1907. No. 82426.

Diving Apparatus.

The De Pluvy Diving Apparatus. Illustrates and describes a suit of metallic armor which will resist great pressure and thus enable a diver to descend 300. ft. or more. 1200 w. Sci Am Sup—Feb. 2, 1907. No. 82090.

Ferries.

Ferry-Steamers for the Hooghly. Illustrations and description of the engines fitted into one of seven twin-screw ferry steamers for the Port of Calcutta. Brief description of the vessels also. 700 w. Engng—Feb. 1, 1907. No. 82254 A.

The Car Ferry Traffic of Lake Erie. W. Frank M'Clure. Illustrates and describes the service between Ohio and Canadian harbors, especially the transport of coal in winter. Shows various types of vessels. 1300 w. Sci Am—Feb. 16, 1907. No. 82422.

Hydroplane Boats.

Recent Performances of French Hydroplane Boats. An illustrated account of the remarkable performance of hydroplane gliding boats in the vicinity of Paris, describing details of interest. 2500 w. Sci Am. Feb. 23, 1907. No. 82572.

Milan Congress.

The Milan Navigation Congress of 1905; and Italian Navigation Works and Ports Visited. Leveson Francis Vernon-Harcourt. An account on the visits to works at the conclusion of the proceedings at Milan. 13500 w. 2 plates. Inst of Civ Engrs—No. 3621. No. 82034 N.

Models.

The Model-Maker of Maiden Lane. Illustrates some fine marine models and other work executed at a shop in New York City. 1600 w. Am Mach—Vol. 30. No. 6. No. 82167.

Motor Boats.

Marine Oil Engine for Commercial Purposes. A. F. Evans. Abstract of a paper read before the British Motor Boat Club, upon the underlying principles of the motor boat in commerce. 1700 w. Auto Jour—Feb. 9, 1907. No. 82450 A.

Influence of the Automobile on Launch Development. W. P. Stephens. Notes on recent development, describing some of the types and the improvements in engine design. 1500 w. Sci Am—Feb. 23, 1907. No. 82574.

The Motor Torpedo Boat—A New Type—Illustrated description of the Yarrow motor torpedo boat for the British Navy. 500 w. Sci Am Sup—Feb. 23, 1907. No. 82579.

Latest Types of Cruising Power Boats. Illustrated description of recent types, with editorial on the trend of motor-boat development. 2700 w. Sci Am—Feb. 23, 1907. No. 82573.

Naval Efficiency.

Personnel—A Vital Factor in Naval Efficiency. Walter M. McFarland. An introduction to a paper, by Commander Worthington, on naval education and the training given at the U. S. Naval Academy at Annapolis. 1000 w. Engineering Magazine—March, 1907. No. 82632 B.

Ore Shipment.

The Transportation and Shipment of Ore. Introductory remarks on methods of handling iron and copper ores in Spain, with an illustrated detailed description of the storage and shipment arrangements at Almeria, Spain. 3000 w. Engng—Jan. 25, 1907. Serial. 1st part. No. 82152 A.

Propellers.

Experiments with Ship Propellers (Vergleichsversuche an Schiffschrauben). H. Lorenz. Mathematical treatment. Diagrams and tables. 2200 w. Zeitschr d Vereines Deutcher Ingenieure—Jan. 5, 1907. No. 82355 D.

Propulsion.

Marine Gas Propulsion in Relation to Imperial Commerce and Defence. A. Vennell Coster. Discusses the relative merits of gas reciprocating engines, steam turbines, and steam reciprocating engines for marine purposes, and explains a safe scheme of marine gas propulsion. Ills. 4500 w. Engr, Lond—Feb. 15, 1907. No. 82613 A.

The Damage to the Steamer Martha Woermann (Die Havarie des Hamburger Dampfers "Martha Woermann"). Hugo Buchholz. Description of rapid work in repairing a broken rudder and stern post. Illus. 2400 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 19, 1907. No. 82360 D.

Sailing Vessels.

The Passing of American Square-Rigged Vessels. James G. McCurdy. Remarks on the rapid disappearance of this type of vessel, and the conditions causing it. Ill. 1500 w. Sci Am Sup—Feb. 16, 1907. No. 82423.

Sea-Rafts.

The Sea-Rafts of the North-West. Day Allen Willey. An illustrated article showing the enormous dimensions and general construction of these timber rafts. 1200 w. Sci Am—Feb. 2, 1907. No. 82085.

Shipbuilding.

The World's Shipbuilding in 1906. Gives tables showing the tonnage of vessels launched during the years 1892-1906, with remarks on the output of the last year, and related matters. 2000 w. Engng—Feb. 1, 1907. No. 82255 A.

Signalling.

Submarine Signalling by Means of Sound. An illustrated review of the development of submarine signalling, describing the application at Liverpool. The method consists essentially of a bell as a transmitter, and a tank containing a solution and a microphone as a receiver. 2000 w. Elect'n, Lond—Jan. 25, 1907. No. 82143 A.

Submarines.

The Stability of Submarines. J. G. Johnstone. Describes the important features in a submarine of the diving type, and considers the statical stability and the stability of motion. 3 Plates. 6500 w. Trans Inst of Engrs & Shipbldrs in Scotland—Jan. 22, 1907. No. 82631 N.

Turbine Steamers.

Cunard Steamers Mauretania and Lusitania (Les Paquebots Géants de la Compagnie Cunard). L. Piaud. Description of these great turbine steamers. Illus. 2800 w. Le Génie Civil—Dec. 29, 1906. No. 82320 D.

Wharf.

The United States Coaling Wharf, Guantanamo, Cuba. Illustrates and describes a wharf for the storage of 20,000 tons of coal and a coal handling plant with a capacity of 200 tons per hour, now under construction. 1000 w. Eng Rec—Feb. 9, 1907. No. 82227.

MECHANICAL ENGINEERING

AUTOMOBILES.

Bodies.

The Names of Motor Carriage Bodies. Explanation of leading types in use, with drawings and index. 2000 w. Autocar—Jan. 26, 1907. No. 82135 A.

Our Vile Bodies. G. Stuart Ogilvie. A discussion of the form of body most suitable for a general utility car. 1800 w. Autocar—Feb. 2, 1907. Serial. 1st part. No. 82235 A.

Change-Speed.

The Stanley Automatic Change-Speed Gear. Illustrated description of a mechanism which, by automatically changing the gears as required, renders a side lever unnecessary. 2500 w. Auto Jour—Feb. 9, 1907. No. 82448 A.

The Wicksteed Change-Speed Gear. Drawing and description of the construction, showing the manner in which the individual clutches are arranged and operated. 1000 w. Auto Jour—Feb. 9, 1907. No. 82449 A.

Cylinders.

The Number of Cylinders. Report of a discussion at the Automobile Club in England on "Six-Cylinder Engines v. Four-Cylinder Engines." 9000 w. Autocar—Feb. 16, 1907. No. 82587 A.

Driving.

Four Wheel Driving and Steering for Electric Automobiles (Elektromobil mit Vierräderantrieb und Vierräderlenkung). E. H. Geist. Description of a car driven by gas-engine dynamo-motor combination with all four wheels drivers. Illus. 1600 w. Zeitschr d Mit Motorwagen Ver—No. 23, Dec., 1906. No. 82309 D.

Fawcett-Fowler.

The Fawcett-Fowler Steam Car. Illustrates and describes a new steam-propelled car, shown at the Liverpool Exhibition. 1000 w. Auto Jour—Feb. 2, 1907. No. 82232 A.

Fuels.

Comparative Test of Alcohol, Kerosene, and Gasoline as Automobile Fuels. Report of a run from New York to Boston, of three identical cars, using the fuels named, giving interesting facts brought out. 1200 w. Sci Am—Feb. 9, 1907. No. 82175.

Grout.

The Grout for 1907. Illustrates and describes this car. The only changes in the new model are in the way of conveniences and appointments. 900 w. Automobile—Feb. 7, 1907. No. 82173.

Hispano Suiza.

A Promising Car from Spain. Illustrated description of the Hispaño Suiza car, shown at Birmingham. 1100 w. Autocar—Jan. 26, 1907. No. 82136 A.

Ignition.

Essential Elements of Electric Ignition. Charles B. Hayward. An explanation of the rudiments, to be followed by a consideration of the various systems of ignition and a statement of their advantages and disadvantages, etc. 3000 w. Automobile—Feb. 21, 1907. Serial. 1st part. No. 82536.

"Kisselkar."

The Kissel Kar. Illustrated description of a popular-priced car built in Wisconsin. 1200 w. Automobile—Jan. 31, 1907. No. 82067.

London Show.

The London Automobile Exhibition (Die Londoner Automobil-Ausstellung). Herbert Bauer. Description of cars at this show, with particulars of engines and general details. Illus. 4600 w. Zeitschr d Mit Motorwagen Ver—No. 23, Dec., 1906. No. 82305 D.

Magnetos.

Simms-Bosch High-Tension Magnetos. Illustrated description of various types. 2000 w. Autocar—Feb. 9, 1907. No. 82452 A.

Motor Cycles.

Motor Cycles at the International Auto Show, Berlin (Die Motorräder auf der Intern. Automobil-Ausstellung, Berlin). Wolfgang Vogel. Detailed description of different types shown at Berlin. Illus. 2800 w. Zeitschr d Mit Motorwagen Ver—No. 24, Dec., 1906. No. 82307 D.

Omnibuses.

Motor Omnibuses. Lord Montagu of Beaulieu. Information in regard to motor omnibuses running in London, discussing their advantages and disadvantages. General discussion. 7500 w. Jour Soc of Arts—Feb. 15, 1907. No. 82584 A.

Motor Cars for Public Service in Paris and Berlin (Automobile im öffentlichen Verkehr von Paris und Berlin). Herbert Bauer. Description, tables of fares, speeds attained, etc. Illus. 5100 w. Zeitschr d Mit Motorwagen Ver—No. 22, Nov., 1906. No. 82304 D.

A New Krieger Gasoline-Electric Omnibus for Use in Paris. Illustrated description. 800 w. Sci Am Sup—Feb. 2, 1907. No. 82089.

Petrol-Electric.

Petrol-Electric Transmission for Road Vehicles in Comparison with Purely Mechanical Systems. E. W. Hart and William P. Durtnall. The present article is principally short illustrated descriptions of the various petrol-electric systems that have been tried, introductory to a statement of the advantages of electric transmission. Editorial also. 4500 w. Elec Engr, Lond—Jan. 25, 1907. Serial. 1st part. No. 82140 A.

Radiators.

Honeycomb Radiators—Their Construction. L. Baudry de Saunier. An illustrated study of these radiators as applied on automobiles. 1300 w. Automobile—Jan. 31, 1907. No. 82065.

Rambler.

Ramblers for 1907. Illustrates and describes the improvements introduced in the new models. 1600 w. Automobile—Jan. 31, 1907. No. 82066.

Side Frames.

Importance of Strength in Side Frames. Thomas J. Fay. Discusses the use of alloy steel, giving the characteristics and composition of various steels, and their suitability, or otherwise, for automobile construction. Ills. 2500 w. Automobile—Feb. 7, 1907. No. 82172.

Spyker.

The 30-42 H.P. Spyker Chassis. A car of Dutch origin, remarkable for its smooth running and reliability, is illustrated and described. 1600 w. Autocar—Feb. 2, 1907. No. 82234 A.

Sturtevant.

The Sturtevant Petrol Car. An American vehicle having an automatic change-speed gear is illustrated and described. 1500 w. Auto Jour—Feb. 2, 1907. No. 82233 A.

Tires.

American Detachable Tires and Removable Rims. C. B. Hayward. An illustrated article reviewing progress in tires, removable rims, and detachable tires. 3300 w. Automobile—Feb. 14, 1907. No. 82299.

Touring Cars.

Bodies, Running Gear and Equipment of Touring Cars (Karosserie, Laufwerk und Ausrüstung von Tourenwagen). Lieut. Herzog. Illus. 2200 w. Zeitschr d Mit Motorwagen Ver—No. 21, Nov., 1906. No. 82303 D.

Traction Engine.

Traction Engine (Motorlastzug). A. Heller. Description of a steam motor driven vehicle for hauling other wagons. Illus. 1300 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 26, 1907. No. 82362 D.

Two-Speed Gears.

Two-Speed Gears for Motor Bicycles. Rev. Basil H. Davies. Brief discussion of whether two-speed gears are necessary, whether there are any practical devices to be had at the present, and the specifications of a technically perfect gear. 2500 w. Auto Jour—Feb. 9, 1907. No. 82451 A.

Weigel.

The 40-H.P. Weigel Car. Illustrates and describes a British built car erected from various parts manufactured by others. Leading characteristics and dimensions are discussed in this number. 1200 w. Auto Jour—Feb. 2, 1907. Serial. 1st part. No. 82231 A.

COMBUSTION MOTORS.

Alcohol.

Denatured Alcohol: Its Manufacture and Some of Its Uses. Henry Leffmann. Information of interest, with short discussion. 2500 w. Pro Engrs' Club of Phila—Jan., 1907. No. 82548 D.

The Use of Alcohol in Combustion Engines. R. E. Mathot. Considers the development of alcohol engines; the properties of alcohol as a fuel; its advantages and applications. Ills. 3000 w. Engr, U S A—Feb. 1, 1907. No. 82102 C.

Comparison.

Internal Combustion Motors and Steam Engines (Moteurs à Combustion Interne et Machines à Vapeur). R. E. Mathot. A comparison of the two types of prime mover. Comprehensive treatment. Diagrams and tables. 15600 w. Revue de Mêcanique—No. 6, Dec. 31, 1906. No. 82319 E + F.

Crank Shafts.

The Weakness of Gas-Engine Crank Shafts. Remarks on the defective designs of gas-engine crank shafts, from an article by J. F. L. Crosland in *Vulcan*. Ills. 900 w. Mech Engr—Feb. 16, 1907. No. 82595 A.

Fuels.

Gasoline, Kerosene, or Alcohol for Marine Explosive Engines. A. E. Potter. Gives a comparison of the heat values of these fuels, discussing their cost and use. 2500 w. Sci Am Sup—Feb. 23, 1907. No. 82581.

Gas Engines.

An Historical Sketch of the Gas Engine. John Hays Hammond, Jr. Brief review of the early history and development, and its application for motive power of automobiles. 2000 w. Yale Sci M—Jan., 1907. No. 82032 C.

Gas-Engine Practice. A discussion of the papers by Prof. H. Hubert, Mr. Tom Westgarth, and Mr. K. Reinhardt. 5000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82514.

Large Size Gas Engines on the Continent. Dr. Alfred Gradenwitz. Discusses their adaptation to iron works and collieries. Ills. 2800 w. Engr, U S A—Feb. 15, 1907. No. 82433 C.

Körting Gas-Engines at the Shelton Iron Works, Stoke. An account of these works and their output, with a description of the gas-engines installed, which are run with coke-oven gas. Ills. 2700 w. Engng—Feb. 15, 1907. No. 82607 A.

Gas Power.

Large Gas Power Plants. C. E. Douglas. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Discusses the suitability or otherwise of gas plants for works requiring from 200 to 1,500 b. h.p., their reliability and economy. 4500 w. Ir & Coal Trds Rev—Jan. 25, 1907. No. 82158 A.

The Evolution of Gas Power. Discussion of paper by F. E. Junge. 5000 w. Pro Am Soc of Mech Engrs—Feb., 1907. No. 82503 F.

Governing.

Crossley's Governing Device for Internal-Combustion Engines. Brief illustrated description of an ingenious device for controlling the gas valve with a view to varying the power of the impulses to suit the load on the engine. 1000 w. Mech Engr—Feb. 2, 1907. No. 82238 A.

Indicator.

Petrol Engine Indicating. Illustration and particulars concerning the Schulze monograph and its use. 1500 w. Autocar—Feb. 2, 1907. No. 82236 A.

Silencer.

Kennedy's Silencer for Internal-Combustion Engines. Illustrates several forms of a device for cooling and silencing the exhaust gases. 800 w. Mech Engr—Feb. 2, 1907. No. 82239 A.

Suction Gas.

Limitations of Suction Gas Plant. A brief discussion of the minimum and maximum limitations. 1800 w. Elec Rev, Lond—Feb. 1, 1907. No. 82245 A.

The Working of a Suction Gas Plant. Arthur J. Stevens. An illustrated account of the actual working of a small suction gas plant, stating the circumstances and conditions which led to the adoption of this form of power. 2200 w. Min Jour —Jan. 26, 1907. No. 82150 A.

Note on Suction Producer Plant. A. E. Porte. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Considers the heat losses, the fuel, the efficiency, and the fundamental principles on which the suction producer operates, and some of its infirmities. 7800 w. Elec Engr, Lond—Jan. 25, and Feb. 1, 1907. Serial. 2 parts. No. 82244 each A.

Suction Gas Engines and Gas Plants. H. Campbell. Abstract of a paper read before the Leeds Local Sec. of the Inst. of Elec. Engrs. Gives the costs of running gas engines in generating stations, and compares the results with those obtainable by steam plant. Discussion. 4000 w. Elect'n, Lond—Feb. 8, 1907. No. 82459 A.

Suction Gas Engines and Gas Plants. Hugh Campbell's paper on this subject is discussed. Ills. 9000 w. Trans Inst of Engrs & Shipbldrs in Scotland—Dec. 18, 1906. No. 82629 N.

Suction Gas Engines and Gas Plants. Continued discussion of paper by Hugh Campbell. 9900 w. Trans Inst of Engrs & Shipbldrs in Scotland—Jan. 22, 1907. No. 82630 N.

The Use of Suction Gas Producers for Power Purposes. N. T. Harrington. An illustrated description of a suction gas producer, discussing the different classes of work to which it is applicable, performances, etc. 5000 w. Jour Assn of Engng Socs—Jan., 1907. No. 82497 C.

Tests.

Efficiency Tests on a High-Speed Petrol Motor. B. Hopkinson. Describes tests made on a high-speed petrol motor for efficiency, using a new type of indicator which gives correct diagrams at high speeds. 3500 w. Engng—Feb. 8, 1907. No. 82464 A.

Theory.

Explosion and Combustion Motors (Les Moteurs à Explosion et à Combustion. Les Gazogènes). A. Bochet. Theoretical discussion, diagrams. 3900 w. Bulletin de la Société Internationale des Electriciens—No. 60, Dec., 1906. No. 82318 F.

HEATING AND COOLING.

Buildings.

Heating of Large Buildings by Steam and by Hot Water (Die Wärmeversorgung grosser Gebäudekomplexe mit Dampf und Warmwasser). M. Haller. Comparison of economy and effectiveness of the two systems. Diagram. 3600 w. Gesundheits Ingenieur—Jan. 19, 1907. No. 82351 D.

Cooling for Buildings (Abkühlung von Gebäuden). O. Krell. Mathematical discussion of heat interchange between interior and exterior of different kinds of buildings. Diagrams. 6100 w. Gesundheits Ingenieur—Jan. 5, 1907. No. 82350 D.

Hot Blast.

Hot Blast Heating. Charles L. Hubbard. Considers the subject as covering all forms of heating and ventilation where a fan is used for moving the air. 1100 w. Dom Engng—Feb. 16, 1907. Serial. 1st part. No. 82420.

Hot Water.

Quick Circulating Systems of Hot Water Heating. C. Guitton. Read before the Am. Soc. of Heat. and Vent. Engrs. Briefly reviews the principal features of the systems of Reck, Brückner, Hamelle, Koerting, etc., and describes in detail the Rouquaud system, or circulation by fall. 2800 w. Met Work—Feb. 23, 1907. No. 82517.

Plants.

The Heating, Ventilating and Electrical Equipment of the Claflin Building, New York. Illustrated description of the very complete plant for this ten-story and basement steel and brick structure. 5000 w. Eng Rec—Feb. 23, 1907. No. 82524.

Heating and Ventilating Plant of the United Engineering Building, New York. An illustrated detailed description of both supply and exhaust ventilation, and direct and indirect heating. Ills. 4000 w. Eng Rec—Feb. 16, 1907. No. 82417.

Refrigeration.

Ammonia Fittings. J. C. Calhoun. Discusses various designs and the weak points in each, showing the importance of the proper hanging of pipe lines, and discussing related topics. 3300 w. Ice & Refrig—Feb., 1907. No. 82121 C.

Mechanical Refrigeration. J. C. Goosmann. Discusses some of the physical laws that make possible the artificial production of low temperatures. 1500 w. Engr, U S A—Feb. 1, 1907. No. 82101 C.

A Modern Absorption Ice Plant. William S. Luckenbach. Illustrates and describes in detail the planning and installation of a 60-ton plant. 3000 w. Engr, U S A—Feb. 15, 1907. No. 82435 C.

Steam Heating.

The Carrying Capacity of Pipes in Low-Pressure Steam Heating. William

Kent. Read before the Am. Soc. of Heat. and Vent. Engrs. Gives tables based upon an assumed drop of one pound pressure per 1,000 ft. of length, explaining their use. Discussion. 4000 w. Heat & Vent Mag—Feb., 1907. No. 82614.

Theatre.

Ventilation of the New Theatre in Cologne (Die Lüftung des Neuen Stadttheaters in Köln). Herr Herbst. Description of general method used. 2500 w. Gesundheits Ingenieur—Jan. 5, 1907. No. 82311 D.

HYDRAULICS.

Pumps.

Centrifugal Pumps. Richard C. Williams. An illustrated explanation of their theory, design, and performance. 2200 w. Eng & Min Jour—Feb. 16, 1907. No. 82409.

Modern Pumping and Hydraulic Machinery. Edward Butler. Reviews the development of pumping engines, illustrating and describing early types. 3500 w. Mech Engr—Jan. 26, 1907. No. 82137 A.

Progress in Pumps. Presidential address of Dabney H. Maury before the Illinois Society of Engineers and Surveyors. 2000 w. Eng Rec—Feb. 9, 1907. No. 82229.

MACHINE WORKS AND FOUNDRIES.

Castings.

Brass Castings. J. L. Jones. Read before the Pittsburg Found. Assn. The importance of good molding sand, metal used for brass castings, mixtures, etc. 3500 w. Foundry—Feb., 1907. No. 82271.

Casting Brass on Iron. Louis Luhrsen. Describes a brass bushing cast around a throttle stem for a locomotive. Ills. 1000 w. Foundry—Feb., 1907. No. 82273.

Pattern for a Chilian Mill Mortar. H. J. McCaslin. Illustrates and describes the laying out, construction of the pattern, and molding. 2000 w. Foundry—Feb., 1907. No. 82274.

Crank-Shaft.

Building a Large Crank-Shaft—Some of the Methods Employed. W. Burns. A short description of the tools and methods used in machining and building up of the various parts of a large marine engine crank-shaft. 1500 w. Am Mach—Vol. 30, No. 6. No. 82168.

Drawings.

The Making, Indexing and Filing of Drawings. J. J. Harmon. Read before the Ill. Soc. of Engrs. & Survs. Discusses this subject in detail, describing methods used by different shops. 3300 w. Eng Rec—Feb. 16, 1907. No. 82418.

Electric Driving.

General Adaptation of Electric Motors to Manufacturing Plants. C. H. Darrall. Remarks on the advantages of electric driving, pointing out some valuable features of both the alternating current and direct current systems. 2800 w. Can Soc of Civ Engrs—Jan. 10, 1907. No. 82054 N.

Foundries.

New Plant of the Detroit Steel Casting Co. Illustrates and describes a well-equipped foundry of fireproof construction, where open hearth and converter steel castings are manufactured. 3000 w. Ir Trd Rev—Feb. 14, 1907. No. 82298.

The American Cast Iron Pipe Company's Foundry. Illustrated description of this new plant at Birmingham, Ala. 2500 w. Ir Age—Feb. 7, 1907. No. 82161.

The New Foundries of the Holwell Iron Company, Limited. Illustrated description of new English foundries near Melton Mowbray. 4500 w. Ir & Coal Trds Rev—Feb. 8, 1907. No. 82475 A.

Science in the Foundry. William W. Hearne. Read before the Am. Assn. for the Adv. of Science. Shows why it is necessary for foundrymen to know the analysis of the pig iron or the ore and fuel that are used. 1200 w. Eng News —Feb. 21, 1907. No. 82533.

Furnaces.

Two Novel Heating Furnaces. Illustrated description of two furnaces for tempering small duplicate parts in large quantities. 1000 w. Ir Age—Feb. 14, 1907. No. 82265.

Hammers.

Fairbanks-Morse Pneumatic Hammers. Illustrates and describes a recent patent which was based on an extensive series of experiments. 1000 w. Ir Age—Feb. 14, 1907. No. 82263.

Pneumatic Hammers (Note sur les Frappeurs Pneumatiques). A. Baril. Comprehensive review of the development and construction of these tools and of their manifold uses. Illus. 4700 w. Revue de Mécanique—Jan., 1907. No. 82342 E + F.

Metalworking.

The Census of Metalworking Machinery. Interesting information from a report by F. J. Miller, prepared for the U. S. Census Bureau, covering the production of metalworking machinery in 1904. 4500 w. Ir Age—Feb. 21, 1907. No. 82519.

Oil Furnace.

Melting in an Oil Furnace. F. S. Fasig. An account of the writer's success. 1000 w. Foundry—Feb., 1907. No. 82272.

Patterns.

Metal Patterns. John Magee. Discusses metal patterns for light specialty work. 3000 w. Foundry—Feb., 1907. No. 82275.

Pipe.

Materials and Properties of Wrought Pipe. F. N. Speller. Discusses certain characteristics possessed by the metals used in the manufacture of modern welded pipe and certain qualities which have widened the field of use for tubular goods. Discussion. Ills. 4000 w. Pro Engrs' Soc of W Penn—Jan., 1907. No. 82044 D.

Planer.

A High-Speed Planer. C. Moody. Illustrated detailed description of a planing-machine 30 in. by 30 in. by 8 ft. 3000 w. Mech Engr—Feb. 16, 1907. No. 82597 A.

Power.

The Choice of Motive Power for the Workshop. Rodolphe Mathot. This third and concluding article of a series gives a comparison of burden costs and a study of working examples. 5400 w. Engineering Magazine—March, 1907. No. 82638 B.

Press Tools.

Sectional Press Tools. Built-up Punch and Die for a Circular Blank with Irregular Opening. R. A. Almond. Considers the designing, construction, and working of these tools. Ills. 1000 w. Am Mach—Vol. 30, No. 6. No. 82169.

Shrinkage.

Shrinkage from a Founder's Point of View. W. Roxburgh. Read at British Found. Assn. Considers shrinkage in metal castings, the warping or twisting due to unequal cooling, and related matters. Ills. 2500 w. Foundry—Feb., 1907. No. 82270.

Testing.

Sankey's Workshop Testing-Machine. Illustrated description of this machine and its operation. 1200 w. Engng—Feb. 15, 1907. No. 82608 A.

Tools.

Some New and Useful Electric Hand Tools. A. Frederick Collins. Various portable hand tools, driven by electricity, are illustrated and described. 1500 w. Sci Am—Feb. 23, 1907. No. 82576.

Car Wheels.

The Manufacture of Cast Iron Car Wheels. An illustrated review of the development of the circular floor, straight line and continuous systems, and the introduction of labor saving equipment. 3000 w. Ir Trd Rev—Feb. 7, 1907. No. 82181.

MATERIALS OF CONSTRUCTION.

Alloys.

Eighth Report to the Alloys Research Committee: On the Properties of Alloys of Aluminium and Copper. Prof. H. C. H. Carpenter and C. A. Edwards. A full report of research carried out by the authors, explaining the scheme, the materials used, and methods. Ills. 38000 w. Inst of Mech Engrs—Jan. 18, 1907. No. 82049 N.

MEASUREMENT.

Air Resistance.

Canovetti's Air-Resistance Experiments. An illustrated account of investigations made by this Italian engineer on the Como Brunate inclined plane. 1200 w. Sci Am—Feb. 23, 1907. No. 82575.

Air Pressure on a Moving Surface (Pression de l'Air sur une Surface en Mouvement. Etude due Coefficient K). J. Rodet. Mathematical treatment. Diagrams. 1900 w. Revue de Mécanique—Jan., 1907. No. 82343 E + F.

Pallograph.

Machine for Recording the Vibration of Ships. Daniel M. Luehrs. Illustrates and describes an invention of E. Otto Schlick, explaining its method of recording. 1800 w. Sci Am—Feb. 9, 1907. No. 82176.

Superheating.

A Dynamical Method of Determining Experimentally the Specific Heat Under Constant Pressure of Superheated Steam. Sydney B. Bilbrough. Describes the practical carrying out of these experiments, also what values can be deduced from the results. 14800 w. Jour of Transvaal Inst of Mech Engrs—Dec., 1906. No. 82055 E.

Tachometer.

Influence of a Tachometer on Governor Regulation (Der Einfluss des Tachometers auf den Reguliervorgang indirekt wirkender Regulatoren). Philipp Ehrlich. Mathematical analysis and treatment of the subject. Diagrams. Serial. 3 parts. 7200 w. Elektrotech und Maschinenbau—Jan. 13, 20 and 27, 1907. No. 82339 D.

Temperature.

Thermometers and Pyrometers. Robert S. Whipple. Address delivered before the Syracuse, N. Y., Chem. Soc. and the Tech. Club. An account of some of their industrial applications. Ills. 5500 w. Ir Age—Feb. 7, 1907. No. 82164.

Venturi Meter.

The Venturi Meter. Illustrates and describes the design, explaining the principle involved. 500 w. Prac Engr—Feb. 15, 1907. Serial. 1st part. No. 82594 A.

POWER AND TRANSMISSION.

Bearings.

Bearings and Their Lubrication. Francis H. Davies. Discusses methods of lubricating, the importance of good lubricating oils, hot bearings, etc. 2000 w. Elec Wld—Feb. 2, 1907. No. 82134.

Cranes.

A 150-Ton Giant Crane. Illustrated

detailed description of a large crane for harbor work, built at British works, with some reference to German types. 2500 w. Engr, Lond—Feb. 1, 1907. No. 82260 A.

Electrically-Driven Transportable Gantry Cranes of 4,000 KG. Lifting Power, with Patented Universal Discharging Device. Illustrated description of a crane for the Cologne-Deutz harbor. 1100 w. Prac Engr—Feb. 1, 1907. No. 82593 A.

Overhead Travelling Revolving Foundry-Crane. Illustrated description of a new type of crane as regards the application and method of working, built in Nuremberg. 500 w. Engng—Jan. 25, 1907. No. 82155 A.

Electric Cranes at the Nuremberg 1906 Exposition (Die Bayerische Jubiläums-Landes-Ausstellung in Nürnberg 1906). A. Hundt. Description of jib and traveling cranes, with diagrams of the wiring. Illus. 1900 w. Elektrotech Zeitschr—Jan. 31, 1907. No. 82332 B.

Electric Driving.

Electrical Equipment of the West Virginia Pulp and Paper Company, Piedmont, W. Va. Illustrated description of the conversion of a plant from steam to electric power without interruption of service. 3500 w. Elec Wld—Feb. 9, 1907. No. 82197.

Electrically-Driven Rolling Mills. Abstract of a paper by G. M. Brown, before the Rugby Engng. Soc. Discusses the application of electricity to the exacting work of driving main rolls, examining the mechanical features of the problem and the various methods by which electric driving has been made practically and commercially feasible. Ills. 3800 w. Elec Engr, Lond—Feb. 1, 1907. Serial. 1st part. No. 82243 A.

Elevators.

Test of a Plunger Elevator Plant. Discussion of paper by A. J. Herschmann. Ills. 6200 w. Pro Am Soc of Mech Engrs—Feb., 1907. No. 82504 F.

Power Plant.

The Planning and Construction of the Power Plant. A. E. Dixon. This seventh, and last, article of Mr. Dixon's series deals with the design and arrangement of the central station building, giving illustrations of recent work. 3800 w. Engineering Magazine—March, 1907. No. 82634 B.

STEAM ENGINEERING.

Blowing Engine.

A Novel Blowing Engine. An illustrated description of the Nordberg blowing engine, which has an entirely new positive valve motion giving extra large valve areas. 2200 w. Am Mach—Vol. 30, No. 6. No. 82165.

Boilers.

A Comparison of Boiler Types. M. T. Goss. Discusses the best type of boiler for efficiency and maintenance, aiming to give suggestions to develop steam power for less cost. 2200 w. Min Rept—Feb. 21, 1907. No. 82563.

Steam Boilers. Angus Sinclair. From "Development of the Locomotive Engine." States the principal requisites of a well-designed boiler, considering briefly various forms, and the modern firebox. 1600 w. Ry & Loc Engng—Feb., 1907. No. 82125 C.

Testing Boilers. Methods of finding efficiency, horse-power and evaporation per pound of coal. Ills. 2000 w. Engr, U S A—Feb. 15, 1907. No. 82434 C.

Boiler and Setting. Discussion of paper by A. Bement on this subject. 4500 w. Pro Am Soc of Mech Engrs—Feb., 1907. No. 82505 F.

Specifications for a Three-Furnace Single-Ended Scotch Boiler. Gives a typical set of specifications representing the best marine boiler construction at the present time. Ills. 4500 w. Boiler Maker—Feb., 1907. No. 82128.

The Temperley-Cockburn Boiler. Illustrates and describes a new system of working water-tube boilers, which aims to secure additional output and efficiency. 3000 w. Engng—Feb. 8, 1907. No. 82467 A.

Boilers in London Electric Stations (Die Dampfkessel in den Elektrizitätswerken Londons). R. Lind. Enumeration and description of different kinds and sizes of boiler in use. Illus. 5200 w. Zeitschr d Vereines Deutscher Ingenieure —Jan. 12, 1907. No. 82358 D.

Coal Tests.

Illinois Coal Tests. Henry B. Dirks. Read before the Illinois Soc. of Engrs. & Survs. A report of tests made of these coals for their heat value, and for their adaptability to power-gas production, and on the washing and coking of coals. 2000 w. Eng Rec—Feb. 23, 1907. No. 82523.

Testing and Purchasing Coal for Steam Plants. A. O. Doane. Discusses methods of sampling and testing coal and the advantage of frequent tests to large consumers. 3500 w. Eng News—Feb. 7, 1907. No. 82184.

Condensers.

Condenser Piping for Steam Turbines (Zentralkondensationen zum Anschluss von Dampfturbinen). Herr Stach. Illus. 3800 w. Glückauf—Dec. 22, 1906. No. 82321 D.

Cooling Towers.

Cooling Tower Practice. Jos. H. Hart. Explains the usefulness of cooling towers, their object, reliability, durability, cost, etc. 1700 w. Elec Rev, N Y—Feb. 16, 1907. No. 82406.

Engine.

Tandem Valve Steam Engine (Tandem-Ventildämpfmaschine, Bauart Lentz). Karl H. Merk. Engine with Lentz valves. Illus. 800 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 26, 1907. No. 82363 D.

Feeding Systems.

Boiler Feed-Piping. R. T. Strohm. Considers feed-water systems and matters relating to them. Ills. 2000 w. Elec Wld—Feb. 2, 1907. No. 82133.

Governor.

New Speed Governor (Neuere Geschwindigkeitsregler). Ferd. Strnad. Description of a new type of inertia governor for steam engines. Serial. 2 parts. 5000 w. Illus. Zeitschr d Ver Deutscher Ing—Jan. 5 and 12, 1907. No. 82357 each D.

Inspection.

Construction Inspection of Boilers and Engines. J. R. Thompson. The present article deals with the inspection of boiler work through all the stages of construction. Ills. 3800 w. Cassier's Mag—Feb., 1907. Serial. 1st part. No. 82285 B.

Smoke.

Smoke Prevention in the Power House. C. H. Benjamin. Explains why smoke abatement saves fuel, and the value of the mechanical stoker for securing good combustion, illustrating and describing types. 2200 w. Cassier's Mag—Feb., 1907. No. 82286 B.

Specific Heat.

Influence of Pressure and Temperature on the Specific Heat of Steam (Die Abhängigkeit der spezifischen Wärme Cp des Wasserdampfes von Druck und Temperatur). O. Knoblauch and Max Jakob. Comprehensive account of recent determinations of this constant. Illus. Serial. 2 parts. 9900 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 19 and 26, 1907. No. 82361 each D.

Superheating.

Present Practice in the Use of Superheated Steam. Reginald Pelham Bolton. A review of American engineering practice during the last ten years in this field, the progress and the economy effected. 3300 w. Engineering Magazine—March, 1907. Serial. 1st part. No. 82635 B.

Turbines.

900 Horse-Power Turbine for India. Illustrated description of one of the most powerful turbines yet made. 800 w. Engr, Lond—Feb. 8, 1907. No. 82473 A.

The Development and Present Status of the Steam Turbine in Land and Marine Work. Discussion of E. M. Speakman's paper. 3000 w. Trans Inst of Engrs & Shipbldrs in Scotland—Dec. 18, 1906. No. 82628 N.

Steam Turbines with Jet Condensers (Dampfturbinen mit Einspritzkondensation). F. Niethammer. 600 w. Zeitschr für das Gesammte Turbinenwesen—Jan. 10, 1907. No. 82365 D.

Valve Gears.

Some Leading Types of Valve Gears. Illustrated detailed descriptions of various types. 1600 w. Mech Engr—Feb. 16, 1907. Serial. 1st part. No. 82596 A.

Guided Valve Gear for Poppet Valves (Zwangläufige Ventilsteuerung mit Flachregler). R. Proell. Analytical discussion of valve arrangements for steam engines. Illus. 4800 w. Zeitschr d Ver-Deutscher Ing—Jan. 26, 1907. No. 82364 D.

Water Softening.

Notes on Water Softening. W. D. Collins. Read before the Indiana Engng. Soc. Gives results of experimenting with different methods, explaining the methods of determining the constituents. 2500 w. Eng Rec—Feb. 16, 1907. No. 82412.

MISCELLANY.

Aeronautics.

Aërial Locomotion with a Few Notes of Progress in the Construction of an Aërodrome. Alexander Graham Bell. An address before the Washington Acad. of Sci. An illustrated review of work accomplished with flying machines, especially the writer's experiments with kites. 8500 w. Nat Geog Mag—Jan., 1907. No. 82046 C.

Progress in Airships. Forms of Gas Bags. Carl E. Myers. Points out defects in the construction of gas bags and reviews some experiments in aeronautics made by the writer. 1600 w. Sci Am Sup—Feb. 9, 1907. No. 82180.

Recent Progress in Aërial Navigation. J. D. Fullerton. A discussion of dirigible ballooning, or navigation by machines lighter than air, and aviation, or navigation by machines heavier than air, giving a list of journals containing useful information on aërial navigation. Ills. 17800 w. Jour Ry U S Inst—Jan., 1907. No. 82048 E.

The Flights of Zeppelin's Airship on October 9 and 10, 1906. An illustrated account of these trials. 1600 w. Sci Am Sup—Feb. 23, 1907. No. 82580.

Aeroplane.

The Tani Aeroplane Model. Illustrated detailed description of an original idea for obtaining mechanical flight. 1500 w. Auto Jour—Feb. 16, 1907. No. 82586 A.

Air Compressors.

Piston Compressors and Turbo-compressors (Kolbenkompressor und Turbokompressor). E. W. Köster. Discussion of the relative advantages of the two kinds. Tables. 1900 w. Glückauf—Dec. 29, 1906. No. 82322 D.

Dynamics.

On Simplicity of Method in Elementary Dynamics. E. V. Huntington. Gives easily remembered working rules or principles, showing, by examples, how ordinary problems can be solved by reference to them. 2200 w. Harvard Engng Jour—Jan., 1907. Serial. 1st part. No. 82620 D.

Energy.

Conversion of Energy and Dynamics of Muscular Force. J. E. Siebel. A review of the fundamental laws of heat energy and its conversion into motion; the animal organism as a basis for study of electrical energy; energy conversion by means of electric battery that has its counterpart in the muscular system. Ills. 3200 w. Ice & Refrig—Feb., 1907. No. 82120 C.

Engineering Building.

The New Engineering Building and Equipment of the University of Pennsylvania. Illustrated detailed description. 4500 w. Pro Engrs' Club of Phila—Jan., 1907. No. 82549 D.

Equilibrium.

The Equilibrium of Least Stability in a Non-Rigid System (Sull' equilibris di minima stabilità dei sistemi deformabili). A. Ciappi. Mathematical paper, diagrams. 5300 w. Annali della Societa degli Ingegneri e degli Architetti Italiani—No. 2, 1906. No. 82313 D.

Guns.

A New Vickers Automatic Rifle-Calibre Gun. Illustrates and describes a new Vickers gun intended for naval and field use. 4500 w. Engng—Jan. 25, 1907. No. 82154 A.

Inflammable Liquids.

Storage of Inflammable Liquids (Die Lagerung feuergefährlicher Flüssigkeiten). Herr Reichel. Methods described for storing benzine and gasoline so as to diminish fire risk. Illus. 3600 w. Zeitschr d Mit Motorwagen Ver—No. 24, Dec., 1906. No. 82308 D.

MINING AND METALLURGY

COAL AND COKE.

By-Products.

Coke-Oven Recovery Products in 1906. Reports in regard to sulphate of ammonia, pitch, carbolic acid, naphthas, and benzols. 1800 w. Col Guard—Feb., 1907. No. 82251 A.

China.

Coal Mining in China. Noah Fields Drake. An account of the crude methods still used for mining, and a discussion of the various mines being developed. Ills. 1800 w. Min Wld—Feb. 16, 1907. No. 82446.

Coal Mining.

Early Coal Mining in the Lackawanna Valley. William H. Richmond. A history of the development of the mining and transportation industries. 2000 w. Mines & Min—Feb., 1907. No. 82111 C.

Coal, Origin, Formation, and Methods of Mining. P. Y. Cox. A short paper followed by an illustrated description of an underground trip and of other features of coal mining in Pennsylvania. 4000 w. Pro Ry Club of Pittsburgh—Nov., 1906. No. 82490 C.

Our Coal. F. Z. Schellenberg. Describes the bituminous deposits of Western Pennsylvania, the methods of mining, ventilation, and related matters of interest. Also discussion. 7500 w. Pro Engrs' Soc of W Penn—Jan., 1907. No. 82045 D.

A Single-Room System of Mining. H. S. Gay. Read before the Coal Min. Inst. of America. Explains an adaptation of the Longwall method to work in thick seams. Ills. 3300 w. Mines & Min—Feb., 1907. No. 82115 C.

The Use of Electricity in Anthracite Mining. H. M. Warren. Illustrates and describes modern equipment, comparing its advantages with obsolete methods. Refers particularly to improvements made in the coal-mining department of the Lackawanna Railroad. 1000 w. Eng & Min Jour—Feb. 2, 1907. No. 82098.

Coke.

The Coke Supply of the United States. Edward W. Parker. A description of present and future sources. Map. 5500 w. Ir Age—Feb. 7, 1907. No. 82163.

Coke Ovens.

Coke Oven Materials. J. M. McKinley. Read before the Coal Min. Inst. of America. Discusses the behavior of coke-oven brick made of different materials and in varying proportions. 2000 w. Mines & Min—Feb., 1907. No. 82113 C.

Disasters.

Causes and Prevention of Disasters in Mines. G. Farmer. Colliery disasters are especially considered, their causes, and means of lessening the danger. 4400 w. Cassier's Mag—Feb., 1907. No. 82282 B.

Fires.

Coal Mine Fires. R. V. Norris. Considers the causes, the precautions to be observed, and successful methods of attack. 2500 w. Eng & Min Jour—Feb. 9, 1907. Serial. 1st part. No. 82194.

Gases.

The Action of Coal-mine Gases. Richard Lee. Briefly explains the effects of breathing carbon monoxide, fire-damp, and after-damp. 900 w. Eng & Min Jour—Feb. 9, 1907. No. 82195.

Haulage.

Underground Haulage. T. Nevin. Describes endless rope and endless chain haulage systems in use in British coal mines. 2000 w. Min Wld—Feb. 9, 1907. No. 82213.

Illinois.

Coal Mining in Eastern Illinois. F. W. Parsons. Illustrated description of details of equipment, and methods employed by The Dering Coal Company. 1400 w. Eng & Min Jour—Feb. 16, 1907. No. 82410.

Lignite.

Lignite of Northeastern Wyoming. Stewart Kennedy. Describes extensive coal fields being rapidly opened along the C. B. & Q. Railroad. Ills. 2500 w. Mines & Min—Feb., 1907. No. 82110 C.

Michigan.

Coal Mining in Michigan. George E. Edwards. A report of the coal deposits, methods of mining, development, etc. 2000 w. Min Wld—Feb. 9, 1907. No. 82214.

Production.

Mining Statistics. E. W. Parker. Read before the Coal Mining Inst. of America. Statistics in regard to the production of coal, showing the great increase in tonnage in recent years. 1800 w. Mines & Min—Feb., 1907. No. 82112 C.

South Africa.

A Comparison of Certain South African Coals. Interesting comparative data from a paper by F. A. D. Moseley concerning the coals of Natal and Middelburg, Transvaal. 1200 w. Engr, Lond—Feb. 8, 1907. No. 82474 A.

Submarine Mines.

Submarine Coal Mining in Cape Breton. W. P. Deppe. An illustrated article giving a short description of the workings of the Mabou mines. 1400 w. Ry Age—Feb. 22, 1907. No. 82561.

Virginia.

The Richmond Coal Basin. Edward K. Judd. Describes the deposits of this field in Virginia, giving brief history of the development. 1400 w. Eng & Min Jour—Feb 9, 1907. No. 82196.

COPPER.

Alaska.

Copper Prospects of Prince William Sound. U. S. Grant. From Bul. of the U. S. Geol. Survey. A report on the ores of the district and the development work. 500 w. Eng & Min Jour—Feb. 2, 1907. No. 82004.

Analysis.

Analysis of Industrial Copper. Messrs. Hollard & Bertiaux. Trans. from *Bul. de la Soc. Nat. pour l'Encour. de l'Ind.* Describes details of operation, dealing with impurities separately. 3000 w. Min Jour—Feb. 9, 1907. No. 82462 A.

Arizona.

Copper Mining at Bisbee, Arizona. Robert B. Brinsmade. Gives the history of the discovery and development, describing the formations, methods of mining, and mechanical equipment of the principal plants. 6000 w. Mines & Min—Feb., 1907. No. 82109 C.

Mattes.

Relative Elimination of Iron, Sulphur, and Arsenic in Bessemerizing Copper-Mattes. E. P. Mathewson. A record of experiments made at Anaconda, Mont., for the purpose of determining the relative speed of elimination of the iron, sulphur and arsenic during the process of bessemerizing copper-mattes. 600 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82507.

Nevada.

Mining Conditions at Ely, Nevada. Edward W. Ralph. A report of recent development of the sulphide copper deposits, and remarks on the conditions at the present time. Map and geological section. 1400 w. Min & Sci Pr—Jan. 26, 1907. No. 82069.

The Copper Deposits of the Robinson Mining Districts of Nevada. Andrew C. Lawson. A description of the geological formation of these deposits. 1100 w. Min Rept—Feb. 14, 1907. No. 82441.

Sulphides.

The Constitution of Ferro-Cuprous Sulphides. H. O. Hofman, W. S. Caypless, and E. E. Harrington. An investigation intended to supplement the paper of A. Gibb and R. C. Philp, on "The Constitution of Mattes Produced in Copper Smelting," by drawing the freezing-point curve of the series ferrous sulphide cuprous sulphide, and seeing how the constitution could be further revealed by microscopic work. Ills. 3000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82509.

GOLD AND SILVER.

Arsenides.

Roasting of the Argentiferous Cobalt-Nickel Arsenides of Temiskaming, Ontario, Canada. Henry M. Howe, William Campbell, and Cyril W. Knight. Gives results of an investigation of their behavior in roasting, aiming to determine the temperature at which the arsenic is most rapidly expelled, the thoroughness of prolonged roasting, the effect of adding charcoal near the end and at the beginning of the roast. 1800 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82511.

The Treatment of Arsenical Ores. Chester F. Lee. Concerning the Cascade arsenical-gold ores and their treatment. 1200 w. Can Min Rev—Feb., 1907. No. 82440 B.

Assay.

The Assay of Silver Bullion by Volhard's Method. Ernest A. Smith. Describes this method showing that it is more accurate than the Gay-Lussac method, though not likely to supersede it for commercial bullion assays. 2000 w. Inst of Min & Met, Bul 28—Jan. 10, 1907. No. 82624 N.

Australia.

Geology and Mining at Broken Hill. Ralph Stokes. Describes the rocks and ores, and the mining and timbering methods now employed. Ills. 2800 w. Min Wld—Feb. 23, 1907. No. 82564.

Industrial Conditions at Broken Hill. Ralph Stokes. An illustrated account of this silver-lead district, describing the deposits, and giving information concerning the production, development, etc. Ills. 2000 w. Min Wld—Feb. 16, 1907. No. 82447.

Individual Records of Kalgoorlie Producers. Ralph Stokes. Review of the profitable producers and their methods of mining. Ills. 1700 w. Min Wld—Feb. 2, 1907. No. 82119.

Metasomatic Processes in the Gold Deposits of Western Australia. Waldemar Lindgren. Describes the geological aspects of the country, the occurrence of the gold-bearing lodes, and the associated minerals, calling attention to points in the history of these deposits. 2000 w. Min Jour—Feb. 2, 1907. Serial. 1st part. No. 82249 A.

California.

Geology of the Exposed Treasure Lode, Mojave, California. Courtenay De Kalb. Describes the character of the changes found in the deeper levels of this gold mine of Southern California, and studies the causes and geology of the region. Ills. 3500 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82508.

Cobalt.

The Cobalt District, Ontario. H. W. Hardinge. Describes this mining district and its development. 1700 w. Min Wld—Feb. 9, 1907. No. 82212.

Cobalt Mining in Canada. Allan Porter. An account of this new mining region and its methods. Silver has been the principal output, but there is a high percentage of cobalt, some gold, arsenic, nickel, galena, copper, and other minerals of value. 2000 w. Sci Am—Feb. 2, 1907. No. 82084.

The Nipissing and Foster-Cobalt Mines. Reginald Meeks. An illustrated description of these silver mines, the methods of mining, character of ore, etc. 2200 w. Eng & Min Jour—Feb. 9, 1907. No. 82191.

Cyanidation.

The Cyanidation of Raw Pyritic Concentrates. Frank C. Smith. Describes the local and economic conditions at the mines of the Socorro Gold Co., Yuma Co., Arizona, and the results of a study of the treatment needed for these ores. 2000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82506.

Cyanide Practice on Boulder County Ores. Frank Leonard. Describes methods at the Cash mill in Magnolia, showing that the cyanide process can be used successfully with this class of ores. 2000 w. Min Rept—Feb. 14, 1907. No. 82442.

The Bullfrog Cyanide Mill. An illustrated description of the new mill which is being erected at Bullfrog, Nevada. 900 w. Eng & Min Jour—Feb. 23, 1907. No. 82568.

The Butters Cyanide Plant, Virginia City, Nev. Claude T. Rice. Illustrated description of a gold-extraction mill equipped with important labor-saving devices. 2500 w. Eng & Min Jour—Feb. 9, 1907. No. 82190.

Gold-Milling.

Design and Working of Gold-Milling Equipment, with Special Reference to the Witwatersrand. George Alfred Denny. Describes a high-speed stamp-mill and its action, and the various machines used, devices and methods, general reduction and treatment scheme, etc. 2 plates and Ills. 18000 w. Inst of Civ Engrs—No. 3623. No. 82039 N.

Guanajuato.

The Big Shafts of Guanajuato. T. A. Rickard. Describes the surrounding country and especially the four great shafts and the work of unwatering of the San José shaft, giving an interesting account of ancient methods. Ills. 3000 w. Min & Sci Pr—Feb. 9, 1907. No. 82445.

Idaho.

South Mountain, Idaho. Robert N. Bell. Describes this silver-lead property, giving sections. 1200 w. Eng & Min Jour—Feb. 9, 1907. No. 82193.

Mexico.

Mining Conditions in the Mountains of Chihuahua. John B. Farish. Illustrates and describes the Dolores mine and mill, and explains the difficulties of operation in the Sierra Madre. 4000 w. Eng & Min Jour—Feb. 2, 1907. No. 82092.

Old Mexican Methods. Bernard MacDonald. Illustrations and notes giving an idea of past methods used to win the silver from the ores. 700 w. Min & Sci Pr—Jan. 26, 1907. No. 82070.

Occurences.

Some Associations of Gold with Pyrite and Tellurides. Drawings and notes on occurrences showing the relations between gold and pyrite in quartz veins. 1500 w. Min & Sci Pr—Jan. 26, 1907. No. 82068.

Ore Dressing.

Ore Dressing at Broken Hill. G. D. Delprat. Part of a presidential address before the Australian Inst. of Min. Engrs. describing the equipment for concentrating and preparing ores for smelting. Ills. 4200 w. Eng & Min Jour—Feb. 16, 1907. Serial. 1st part. No. 82408.

Placers.

A Mining Enterprise in Colombia. Francis C. Nicholas. Illustrated description of gold placer deposits remarkable both for their high values and for peculiarities of formation. 2000 w. Min Wld—Feb. 9, 1907. No. 82210.

Rolled Silver.

The Manufacture of Rolled Sterling-Silver. Erwin S. Sperry. An interesting article giving an illustrated detailed description of present methods. 5000 w. Jour Fr Inst—Feb., 1907. No. 82061 D.

Siberia.

Gold Mining in Central Siberia. An interview with W. A. Mercer, who has made many prospecting expeditions in Siberia. 4000 w. Min Jour—Feb. 16, 1907. No. 82604 A.

Siberian Proprietary Mines, Limited. Considers the properties in detail. 4000 w. Min Jour—Feb. 16, 1907. No. 82605 A.

Slimes.

A Siphon Device for Removing Floating Material. Edward S. Wiard. Illustrates and describes a device for removing slime, and also suggestive of a means of reducing the volume of water flowing through a tank. 700 w. Min & Sci Pr—Feb. 2, 1907. No. 82208.

The Butters Slime-Filter at the Cyanide Plant of the Combination Mining Company, Goldfield, Nev. Mark R. Lamb. An illustrated description of this filter and its use. 2000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82513.

The Butters Filter. Mark R. Lamb. Illustrated description of this filter and its operation. 500 w. Min & Sci Pr—Feb. 2, 1907. No. 82207.

The Ridgway Filter. Illustrated description of an invention for treating slime containing gold in solution. 1600 w. Min & Sci Pr—Feb. 9, 1907. No. 82444.

Smelting.

Smelting Chloride of Silver. Describes two methods used for obtaining metallic silver in its chloride, giving the advantages of each. Ill. 1200 w. Brass Wld Feb., 1907. No. 82555.

South Africa.

New Brighton Mines, Limited. Report of a visit by C. S. Edmondson, who has specially examined the Bendigo alluvial gold field in South Africa. 3500 w. Min Jour—Feb. 2, 1907. No. 82250 A.

Tube-Mills.

Grinding in Tube-Mills at the Waihi Gold-Mine, Waihi, New Zealand. E. G. Banks. Gives records of working extending over a lengthy period. 1400 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82512.

IRON AND STEEL.

Blast Furnace.

The Lackawanna Steel Co.'s New Furnace. Illustrated detailed description, with history of the erection of stack No. 7, at Buffalo, N. Y. A record of rapid construction and the solution of interesting engineering problems. 2500 w. Ir Trd Rev—Feb. 21, 1907. No. 82518.

The New Blast Furnace Plant of the Frodingham Iron and Steel Company. Illustrated detailed description. 3500 w. Ir & Coal Trds Rev—Jan. 25, 1907. No. 82159 A.

Blast-Furnace Gas.

The Utility of Cleaning Blast Furnace Gas. H. G. Scott. Abstract of a paper read before the Cleveland Inst. of Engrs. and of the discussion. Describes the method of cleaning the gas, the results, and cost. 2500 w. Min Jour—Jan. 26, 1907. No. 82151 A.

Cast Iron.

Cast Iron. E. Adamson. Discusses the effect of temperature on the chemistry of cast iron, grading by fracture, the influence of sulphur, phosphorus, manganese, and other constituents. Plate. 8000 w. Jour W of Scotland Ir & St Inst—Nov., 1906. No. 82621 N.

Charging.

Charging Furnaces by American Methods (Le Chargement des Hauts Fourneaux d'après les méthodes américaines). Ch. Dantin. Description of mechanical conveyors of American design used in France. Illus. 1700 w. Le Génie Civil —Jan. 19, 1907. No. 82324 D.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Furnaces.

The Efficiency of Furnaces. Dr. Joseph W. Richards. Considers thermal efficiency, both absolute and relative, and also discusses economic efficiency as related to minimum cost. 3500 w. Jour Fr Inst—Feb., 1907. No. 82062 D.

Gogebic.

Some Gogebic Mines as Seen in 1906. Gives a comparison of the output of the active mines, and an illustrated description of some of the methods of mining, and facts of general interest. 3800 w. Ir Trd Rev—Jan. 31, 1907. No. 82064.

Metallurgy.

Unsolved Problems in Metallurgy. Robert Abbott Hadfield. "James Forrest" lecture. Deals especially with the modern metallurgy of iron and steel, its problems and means of solving them. 12000 w. Inst of Civ Engrs—May 2, 1906. No. 82033 N.

The Iron Mines at Cornwall, Pennsylvania. Prof. William E. Ford. An illustrated article giving the location and history of these mines, describing the deposits, methods of mining, and other matters of interest. 1400 w. Yale Sci M—Jan., 1907. No. 82031 C.

Smelting.

Alabama Iron Manufacture. John J. Porter. Discusses possible economies in the blast furnace. 2500 w. Ir Age—Feb. 7, 1907. No. 82162.

Steel Making.

Making Open Hearth Steel at Pueblo. Lawrence Lewis. The basic and acid furnaces at the Colorado Fuel and Iron Company's Steel Works are illustrated and described. 3300 w. Eng & Min Jour—Feb. 23, 1907. No. 82567.

Steel Making at Pueblo. Lawrence Lewis. Illustrates and describes the reconstructed plant of the Colorado Fuel & Iron Co., its equipment and capacity. 2000 w. Eng & Min Jour—Feb. 2, 1907. No. 82096.

Steel Plates.

Manufacture of Steel Plates (La Fabrication des Plaques de Blindage aux Forges nationales de la Chaussade). A. Bizot. Description of processes of manufacture. Illus. 2800 w. Le Génie Civil—Jan. 26, 1907. No. 82326 D.

Steel Works.

The Krupp Works. The present number gives an illustrated description of the Essen Works. 1800 w. Engr, Lond—Feb. 8, 1907. Serial. 1st part. No. 82472 A.

MINING.

British Columbia.

British Columbia in 1906. Arthur Wheeler, Jr. A review of the tonnage and value of the ores mined during the year, dealing with districts. 4000 w. Can Min Rev—Feb., 1907. Serial. 1st part. No. 82439 B.

Concentration.

Concentration. Fritz Cirkel. Address before the Min. Soc. of McGill Univ. on the problems of extraction, concentration and ore treatment. 4500 w. Can Min Rev—Feb., 1907. No. 82438 B.

Dredging.

Dredging and Horticulture. D'Arcy Weatherbe. Gives results of investigations made of facts relating to rendering the land unfit for agriculture by dredging débris. 1000 w. Min & Sci Pr—Feb. 2, 1907. No. 82206.

Drills.

Diamond Drills. James Humes. Explains their utility for underground exploration. 1000 w. Eng & Min Jour—Feb. 23, 1907. No. 82570.

Electric Power.

The Electric Power Installation at Grangesberg Iron Mines, Sweden. G. Ralph. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Illustrated description of the electric mining plant installed. 3000 w. Elec Engr, Lond—Feb. 15, 1907. No. 82599 A.

Estimation.

Development Results vs. Stope Results. E. H. Garthwaite. Gives a comparison of results. 500 w. Inst of Min & Met, Bul 29—Feb. 14, 1907. No. 82626 N.

Haulage.

Yak and Newhouse Tunnels. An illustrated article describing the use of Goodman locomotives for underground haulage in these tunnels. 3000 w. Ores & Metals—Jan. 20, 1907. No. 82091.

Hoisting.

Hoisting in Small Zinc Mines in Wisconsin. George S. Brooks. Discusses the merits of cage-car and tub systems, giving a comparison of costs. 1500 w. Eng & Min Jour—Feb. 23, 1907. No. 82569.

Electrical Winding Plants. Alfred Gradenwitz. An illustrated article giving details of arrangements, with descriptions of several German plants. 2200 w. Eng & Min Jour—Feb. 2, 1907. No. 82097.

Electric Windlass (Elektrisch betriebene Spille). Erich Herrmann. Description of motor driven windlasses as used in Europe. Illus. 1700 w. Elektrotech Zeitschr—Jan. 17, 1907. No. 82333 B.

Kaolin.

Kaolin Mining in Georgia. Otto Veatch. The deposits, method of mining and preparation for market are described. Ills. 1100 w. Eng & Min Jour—Feb. 9, 1907. No. 82192.

Mining Terms.

Spanish-American Mining Terms. H. E. West. An explanation of some of the common words and phrases used in mining regions of Central America. 1800 w. Min & Sci Pr—Feb. 2, 1907. No. 82209.

Mistakes.

Mistakes in the Design of Mining and Reduction Plants. S. A. Worcester. Calls attention to mistakes noted, especially describing certain installations observed. 2000 w. Min & Sci Pr—Feb. 2, 1907. No. 82205.

Potash Works.

The Two-Shaft System for Prussian Potash Works. Robert Grimshaw. States the advantages claimed for the two-shaft system, and explains the proposed law requiring this system, which is soon to be discussed by a mixed commission. 600 w. Eng & Min Jour—Feb. 2, 1907. No. 82095.

Prospecting.

Prospecting for Rare Minerals and Earths. George E. Walsh. Some suggestions of the value of deposits of tungsten, vanadium, molybdenum, etc. 2000 w. Min & Sci Pr—Feb. 16, 1907. No. 82552.

Pumping Plant.

Electrically-Driven Centrifugal Pumping Plant at the Tywarnhaile Mine. W. R. Thomas. A general description of an installation applied to the unwatering of this mine in Cornwall. 3000 w. Inst of Min & Met, Bul 29—Feb. 14, 1907. No. 82625 N.

Rescue Apparatus.

Breathing Masks and Helmets. W. G. Fitz-Gerald. Illustrates and describes the curious apparatus made for use in mines, collieries, gas and chemical works, fire brigades, sewerage works, ships' coal bunkers, and many other industrial concerns, where self-contained breathing apparatus is needed. 1800 w. Sci Am—Feb. 2, 1907. No. 82086.

Safety Measures.

Safety Measures in Mining. Donald Macaulay and Louis G. Irvine. Reply to discussion of papers by these authors. 13600 w. Jour of Chem, Met, & Min Soc of S Africa—Dec., 1906. No. 82544 E.

Sampling.

Some Sampling Results. E. H. Garthwaite. Discusses the question of proper distance between mine samples, especially for gold reefs, giving methods used and results obtained in Rhodesia. 1500 w. Inst of Min & Met, Bul 28—Jan. 10, 1907. No. 82623 N.

Shafts.

Electrically Operated Sinking-Plant. Trans. abstract of article by W. Philippi, in *Elektrotechnische Zeitschrift.* Illustrated description of the plant recently installed at the Wilhelmina Pit, near Haarlem, as typical of this class of work. 900 w. Elec Rev, Lond—Jan. 25, 1907. No. 82142 A.

Refrigeration for Shaft Sinking. Richard Stetefeld. A comparison of the new Oetling freezing shield process with the older Poetsch method, giving comparative cost. Ills. 1800 w. Ice & Refrig—Feb., 1907. No. 82122 C.

Siberia.

Mining on the Kirghese Steppes. H. E. West. An illustrated account of an interesting trip through Southern Siberia, describing the conditions found, the ancient and modern mines, the deposits, etc. 2500 w. Eng & Min Jour—Feb. 23, 1907. No. 82566.

Sulphur.

Sulphur Mining and Refining in Wyoming. L. W. Trumbull. Describes the deposits and the apparatus and methods used in handling and preparing for market. Ill. 1600 w. Mines & Min—Feb., 1907. No. 82114 C.

Timber.

Timber Used in Metal Mines. R. S. Kellogg. Abstract of Circular 49, U. S. Dept. of Agri., giving tables showing the kind and quantity of timber used in mines of precious metals and of iron. 800 w. Min Wld—Feb. 9, 1907. No. 82211.

MISCELLANY.

Crystals.

Modern Theories of Crystal Structure (Les Théories Modernes Sur La Structure Des Mileux Cristallisés). G. Wyrouboff. 8100 w. Revue Génerale des Sciences—Dec. 30, 1906. No. 82312.

Deutschman's Cave.

Deutschman's Cave, Near Banff, B. C., Canada. W. S. Ayres. Map., illustrations, and description of this cavern, discovered Oct. 22, 1904. 4200 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82515 C.

Diamonds.

A Visit to the De Beers Consolidated Diamond Mines. Edgar P. Rathbone. Brief description of methods, mechanical and labor-saving appliances, observed during a recent visit. 1700 w. Inst of Min & Met, Bul 28—Jan., 1907. No. 82622 N.

Himalayas.

Minerals and Metalliferous Lodes of Kulu and Lahaol, Kangra District, Punjab Himalayas. F. C. Hughes. Information in regard to the geology and mineral deposits. Iron, galena, and sapphires were found in Kulu; gold, silver-lead ores, and other minerals in Lahaol. 1500 w. Inst of Min & Met, Bul 29—Feb. 8, 1907. No. 82627 N.

Lime-Roasting.

Laboratory Experiments in Lime-Roasting a Galena Concentrate with Reference to the Savelsberg Process. H. O. Hofman, R. P. Reynolds and A. E. Wells. Experimental investigation of the effects which variations in the addition of limestone and changes in the volume of blast may exert upon desulphurization, fusibility and losses in lead and silver. 3000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82510.

Ore Mixing.

The Adjusting of Ores. L. S. Austin. Remarks on schedules of prices and melting charges, sorting and ore manipulation. 700 w. Eng & Min Jour—Feb. 2, 1907. No. 82093.

Tin.

Cornish Tin Mining. H. E. West. Remarks on the recent revival in tin-mining, reviewing past and present equipment of Cornish mines. Ills. 2000 w. Min & Sci Pr—Feb. 9, 1907. No. 82443.

Zinc.

Dodd City, Ark., Zinc Fields. Illustrated description of this section which promises to become an important producer of lead and zinc. 1200 w. Min Wld—Feb. 23, 1907. No. 82565.

Sheet Ground Mining in the Webb City District. Otto Ruhl. Gives information regarding the profitable mining of low-grade zinc ores, and the development of the "sheet-ground" territory. Ills. 1500 w. Min Rept—Feb. 7, 1907. No. 82204.

Zinc Alloys.

Alloys of Zinc and Iron (Les Alliages de Zinc et de Fer). S. Wologdine. Description of experiments on alloys containing less than 10 per cent. of iron, crystal formation observed, and melting points. Ills. 2400 w. Revue De Métallurgie—Dec., 1906. No. 82310 H.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Car Recording.

A New Method of Car Recording at Local Stations. F. Lincoln Hutchins. Describes a card record system, which has been in use with satisfying results, at the Troy, N. Y., station of the Boston & Maine Railroad, and at other points. 900 w. R R Gaz—Feb. 1, 1907. No. 82077.

Derailment.

Derailment on Curves. H. J. Slifer, with discussion. Considers the principal causes of derailment. 4000 w. Pro Iowa Ry Club—Jan. 11, 1907. No. 82267 C.

Electric Locking.

Electric Locking at Electric Interlocking Plants. W. H. Arkenburgh. Gives diagrams and explanation of two systems. with comments. 800 w. Pro Ry Sig Assn—1906. No. 82484 N.

Freight.

The Profitable Weight and Speed of Freight Trains. M. B. Wild. Editorial letter discussing the economical weight and speed of freight trains. 1000 w. R R Gaz—Feb. 8, 1907. No. 82400.

The Profitable Weight and Speed of Freight Trains. Several letters called forth by the communication by M. B. Wild, discussing the economical weight and speed of freight trains. Also editorial. 6000 w. R R Gaz—Feb. 15, 1907. No. 82401.

Operating Costs.

The Cost of Steam and Electric Locomotive Operation. Gerard B. Werner. Gives an analysis of the reduction in operating costs to be effected by the substitution of electricity for steam on trunk lines. 2000 w. Engineering Magazine—March, 1907. No. 82636 B.

Signalling.

Controlled Manual Block System in Use on Single Track Line of the Illinois Central Railroad. W. W. Salmon. Deals with the reasons that led this railway to adopt the system described, the results obtained, and the cost of its installation and maintenance. 3500 w. Ry Age—Feb. 15, 1907. No. 82427.

Substituting Track Circuits for Detector Bars. W. N. Spangler. A detailed discussion of the working of electric switch locking in signalling, the features to be guarded against, etc. With general discussion. Diagrams. 6000 w. Pro Ry Sig Assn—1906. No. 82481 N.

The Charging of Storage Batteries from Alternating Current Circuits. F. B. Corey. Discusses the source of supply of the charging current for batteries used in signalling. Also discussion. Ills. 4500 w. Pro Ry Sig Assn—1906. No. 82480 N.

The Power Distant Signal. W. A. D. Short. Considers the best means of control for the distant signal. General discussion. 5200 w. Pro Ry Sig Assn—1906. No. 82482 N.

Signalling on the East Bengal State Railways. G. K. Rogers. Illustrates and describes the general arrangement and working of MacKenzie and Holland's Improved Sykes Block. 700 w. Pro Ry Sig Assn—1906. No. 82478 N.

The Optics of the Signal Lens. William Churchill. Aims to give optical data of chief interest to the users of signal lenses, and the optical principles upon which the data depend. Ills. 6500 w. Pro Ry Sig Assn—1906. No. 82486 N.

The Upward Indication of the Semaphore Arm. L R. Clausen. A discussion of the objections to the downward indication for proceed, and the arguments for the upward indication. Ills. 2000 w. Pro Ry Sig Assn—1906. No. 82483 N.

MOTIVE POWER AND EQUIPMENT.

Buffers.

Dimensions of Buffers for Standard Gage Cars (Dimensions à Adopter pour les Disques Tampons de Choc des Véhicules de Chemins de Fer à Voie Normale). M. M. Chabal et Beau. Comprehensive discussion of most efficient size of buffer discs to be used under different conditions. Mathematical treatment. Diagrams. 8800 w. Revue Génèrale des Chemins De Fer—Jan., 1907. No. 82349 G.

Cars.

All-Steel 50-Ton Box Car for the Union Pacific. Photographs, drawings and description. 400 w. R R Gaz—Feb. 22, 1907. No. 82539.

Steel Passenger Cars. Illustrated detailed description of the sample all-steel passenger coach built for the Long Island Railroad. 2000 w. Am Engr & R R Jour —Feb., 1907. No. 82071 C.

Engine Failures.

Engine Failures and Their Report. A paper by W. E. Dunham, introductory to an extended discussion. Ills. 17800 w. Pro W Ry Club—Jan. 15, 1907. No. 82489 C.

Lighting.

Car Lighting. J. R. Cravath and V. R. Lansingh. Discusses the means of securing good illumination and pleasing effect in the electric lighting of cars. Ills. 1200 w. Elec Wld—Feb. 2, 1907. No. 82130.

Locomotives.

Four-Cylinder Compound Locomotives for the Italian State Railroads. Illustrated description of a locomotive at the Milan exposition, which possesses many variations from standard practice. 3000 w. R R Gaz—Feb. 1, 1907. No. 82081.

Locomotives for the Italian Government Railways. Illustrations showing the principal features of American built locomotives of the consolidation type, with single-expansion cylinders, and of the ten-wheel type with balanced compound cylinders, with descriptions. 500 w. Ry Age—Feb. 8, 1907. No. 82202.

Pacific Type Locomotives. Illustrates and describes Pacific type passenger locomotives for the National Railway of Mexico. They include an example of four different cylinder arrangements and of both Walschaert and Stephenson valve gear. 1800 w. Am Engr & R R Jour—Feb., 1907. No. 82075 C.

Mexican Central Oil Burner. A description of this engine, illustrating the firebox. 1000 w. Ry & Loc Engng—Feb., 1907. No. 82126 C.

Four-Cylinder Simple Locomotive. Illustrated description of an Atlantic type locomotive equipped with four simple cylinders. 1200 w. Am Engr & R R Jour—Feb., 1907. No. 82073 C.

Six-Coupled Passenger Express Locomotive; Caledonian Railway. Detailed drawings and description of locomotives used for heavy corridor-train service. 900 w. Engng—Feb. 1, 1907. No. 82256 A.

Four New British Locomotives. Engravings and leading particulars in regard to four engines recently designed and constructed in England. 600 w. Engr, Lond—Jan. 25, 1907. No. 82156 A.

Santa Fe Type Baldwin Locomotive with Superheater, P. S. & N. Ry. Illustrated description of the 30,000th locomotive constructed by the Baldwin Locomotive Works, especially the improved superheater. 700 w. Ry & Engng Rev—Feb. 23, 1907. No. 82559.

Pittsburg Shawmut & Northern 10-Coupled Locomotive. Illustrates and describes an engine using superheated steam economically at a comparatively low pressure. 400 w. Ry Age—Feb. 15, 1907. No. 82428.

Successive Experiments and Improvements on Locomotives of the Pennsylvania Railroad. C. H. Caruthers. An illustrated review of improvements in brakes, smokestacks, and numerous other parts. 6000 w. R R Gaz—Feb. 22, 1907. No. 82537.

Passenger Locomotive with Feed Water Heater (2-4 Gekuppelte Personenzuglokomotive mit Speisewasservowärmern). E. Sauer. A feed water heater located in the smokebox and supplied by a pump. Ills. 5500 w. Zeitschr d Vereines Deutsch Ingenieure—Jan. 5, 1907. No. 82354 D.

Refrigerator Cars.

Refrigerator Cars in France. Illustrates and describes types of cars used by two refrigerator car lines in France, and the shipping of loaded refrigerator cars across the English Channel. 1200 w. Ice & Refrig—Feb., 1907. No. 82123 C.

Resistance.

Train Resistance and Its Calculation by Logical Formulae (Die Widerstände der Eisenbahnzüge und die zu ihrer Berechnung dienenden Formeln). Albert Frank. Comparison of different formulae now in use. 6000 w. Zeitschr d Vereines Deutschr Ingenieure—Jan. 19, 1907. No. 82359 D.

Stokers.

Mechanical Stokers for Locomotives (Mechanische Lokomotir-Bekolungsanlagen). Friedr Zimmermann. Brief review of different devices that have been tried in service. 1700 w. Glaser's Annalen—Jan. 15, 1907. No. 82366 D.

Valves.

Valves and Valve Gearing for Superheated Steam Locomotives. Illustrates and describes two locomotives in service on the Prussian State Railways, fitted with the Lentz system of poppet valves. 1700 w. Mech Engr—Feb. 2, 1907. No. 82237 A.

Wheel Pressures.

Altering Locomotive Wheel Pressures. W. H. Van Druten. Explains a simple method by applying a little elementary mathematics. 1000 w. Am Engr & R R Jour—Feb., 1907. No. 82074 C.

NEW PROJECTS.

Africa.

The Southwest African Railway. Dr. Alfred Gradenwitz. An illustrated account of the construction of the Otavi Railway, which is about 360 miles in length. 900 w. Sci Am Sup—Feb. 23, 1907. No. 82577.

Alaska.

Construction of the Alaska Central Railway, with Cost Data. William G. Atwood. An illustrated account of work done on this road since Jan., 1905. Explains some of the difficulties of railroad construction in a cold country. 3500 w. Eng News—Feb. 21, 1907. No. 82529.

China.

Construction of the Shan Tung Railway (Allgemeines und Technisches vom Bau der Schantungbahn). Alex Wenz. Description of location and construction of the roadway and bridges of this important link in the Chinese railway system. Ills. 6100 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 12, 1907. No. 82356 D.

Tehuantepec.

The Tehuantepec Railway and Terminal Ports. An illustrated description of the railway and the terminal harbors at Salina Cruz and Coatzacoalcos. 4000 w. Engr, Lond—Feb. 1, 1907. No. 82258 A.

PERMANENT WAY AND BUILDINGS.

Four-Track Line.

The New Four-Track Line of the Erie R. R. Through Bergen Hill, Jersey City. Explains the difficulties in the way of railway lines from the west which reach New York City, and describes the new construction work in progress by the Erie R. R. Ills. 1700 w. Eng News—Feb. 21, 1907. No. 82532.

Rails.

Rail Corrugations. R. W. Western. Remarks on the causes after a study of the track of the South London tramways. 2500 w. Tram Ry Wld—Feb. 7, 1907. No. 82591 B.

Rail Corrugation in Great Britain. Gives views of managers and engineers from the principal towns of the country in regard to the cause of corrugation. 9000 w. Tram & Ry Wld—Feb. 7, 1907. No. 82592 B.

Comparison of American and Foreign Rail Specifications, with a Proposed Standard Specification to Cover American Rails Rolled for Export. Discussion of the paper of Albert Ladd Colby. 8000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82516 C.

Rail Fastenings.

On the Working Loose of Screws When Used as Rail Fastenings. L. Schlüssel. Analyzes the behavior of the screw under the influence of unsymmetrical loads, and attempts to deduce a method for preventing such loosening. 6500 w. Bul Int Ry Cong—Jan., 1907. No. 82545 E.

Repair Shops.

Railroad Shop Organization. C. J. Morrison. Compares the working of different shops and the effect on the output, showing the importance of organization. 1300 w. Am Engr & R R Jour—Feb., 1907. No. 82072 C.

Roadway.

Pennsylvania Standard Roadway. Brief illustrated description of the standard adopted, and which is being constructed on the main line. 800 w. Ry Age—Feb. 1, 1907. No. 82076.

Station.

Proposed Union Station, Toronto, Canada. Illustrated description of a proposed passenger station building, including baggage buildings and service plant. 1000 w. Ry Age—Feb. 15, 1907. No. 82429.

Tracks.

A Design for Railway Track, Based Upon a Study of the Stresses Existing in Track Superstructure. O. E. Selby. Abstract of a paper in Bul. 30 of the Am. Ry. Engng. & Main. of Way Assn. Discusses the design of a track structure that will overcome the defects of the present track. Ills. 2000 w. Eng News—Feb. 14, 1907. No. 82294.

Trestle.

Niagara Canyon Trestle. Illustrated description of a wooden trestle in British Columbia, which carries the Esquimalt and Nanaimo Railway. It is 585 ft. long and the height is 120 ft. 700 w. Ry & Loc Engng—Feb., 1907. No. 82124 C.

TRAFFIC.

Car Shortage.

Clearinghouse Idea in Car Service. Editorial discussing the car shortage trouble and the proposed remedy. 1600 w. Ry & Loc Engng—Feb., 1907. No. 82127 C.

I. Is There a Car Famine? P. B. Vermillion. II. Causes and Remedy for Car Shortage. Ashley J. Elliott. Two papers on the causes of car shortage and the handling of equipment, the remedies, etc. General discussion. 7500 w. Pro Iowa Ry Club—Jan. 11, 1907. No. 82268 C.

The Car Shortage Problem. Extracts from the Interstate Commerce Commissioners' report on the causes and remedies. 2200 w. Ir Age—Feb. 21, 1907. No. 82520.

Coal Traffic.

First Report of the Interstate Commerce Commission on the Coal Traffic. A review of this report which deals with bituminous coal carried east of the Ohio River, and bounded on the south by the Norfolk & Western R. R., and on the north by Canada. 4000 w. R R Gaz—Feb. 1, 1907. No. 82078.

Handling the Coal Output in Southern Illinois. E. Wallace. An illustrated account of a coal-traffic railway also operated as an interurban trolley line. 500 w. Eng & Min Jour—Feb. 23, 1907. No. 82571.

Freight Traffic.

Watching Freight Traffic by Daily Returns. Describes methods in use on one important British railway and one important American railway, comparing the use made of actual working statistics. Also editorial. 5500 w. R R Gaz—Feb. 1, 1907. No. 82079.

Problems.

Some Railroad Problems. J. B. Thayer. From an address before the Traffic Club of New York. Discusses rebates, rates, passes, present and proposed legislation, etc. 3500 w. Ry & Engng Rev—Feb. 23, 1907. No. 82560.

Report.

Final Report of the Pennsylvania Railroad Special Investigating Committee. Abstract of the report of a committee appointed to investigate charges brought against officers and employees. 4500 w. R R Gaz—Feb. 22, 1907. Serial. 1st part. No. 82538.

MISCELLANY.

Alaska.

The Territory of the Alaska Central Railroad. A. S. Atkinson. Remarks on the development of railroads in Alaska, especially the route of the Alaska Central, and the difficulties, and the rich mineral country through which it passes. 2000 w. R R Gaz—Feb. 15, 1907. No. 82403.

Atmospheric System.

Atmospheric Railroad Traction. W. B. Poley. An illustrated description of this system, and an account of the trials made of it from 1840 to 1860. 1500 w. R R Gaz—Feb. 1, 1907. No. 82080.

Legislation.

Railroad Legislation. George F. Baer. Letter to the Pennsylvania Legislature, giving a statement of the present conditions of railroad transportation. 2800 w. R R Gaz—Feb. 15, 1907. No. 82402.

STREET AND ELECTRIC RAILWAYS

Brake.

The Freund Tramway Brake. Illustrated description of this system which seems to have many practical advantages. 1800 w. Engng—Feb. 15, 1907. No. 82609 A.

Brooklyn Elevated.

The Elevated Shops and Terminals of the Brooklyn Rapid Transit Company—Organization and General Layout at East New York. An illustrated article dealing with the elevated railway shop, terminal construction and operating practices of this company as developed within the last two years. 3000 w. St Ry Jour—Feb. 2, 1907. Serial. 1st part. No. 82116.

Cars.

New Motor Cars for the Metropolitan West Side Railway. Illustrated description of new cars for this Chicago line, which are well adapted to its service and traffic conditions. 1200 w. Elec Ry Rev—Feb. 9, 1907. No. 82217.

Car Houses.

New Car Houses in Baltimore. Illustrated description of the eight car houses, in which special attention has been given to fire protection. 3500 w. St Ry Jour—Feb. 2, 1907. No. 82117.

Car Speeds.

Notes on Speed Time Curves. Tracy W. Simpson. An explanation of a method of plotting speed time curves, and a study of the usefulness of such curves for determining important questions. 3500 w. St Ry Jour—Feb. 9, 1907. No. 82216.

Conduit Systems.

Electric Conduit Street Railroads. C. H. Stut. Discusses the requirements of a good conduit system, especially in reference to the conditions at San Francisco. 1700 w. Cal Jour of Tech—Jan., 1907. No. 82052.

Distribution System.

Feeder and Return Systems. Henry Docker Jackson. Considers rail bonds, cost of distribution systems, and related matters. 1500 w. Elec Ry Rev—Feb. 9, 1907. No. 82218.

Drop.

Drop in Volts. E. Goolding. Explains a method of finding the drop of volts in track, third rail, or trolley wire of any size or length. 1100 w. Tram & Ry Wld—Feb. 7, 1907. No. 82590 B.

Electric Locomotives.

The New Electric Locomotive for the Vienna, Austria, City Lines. C. L. Durand. Illustrates and describes the new electric locomotives which will replace the steam locomotives now in use. 3000 w. Elec Rev, N Y—Feb. 2, 1907. No. 82103.

Illumination.

Car Lighting. R. C. Taylor. Read before the Cent. Elec. Ry. Assn. Considers the requirements of interurban cars carrying passengers for a long distance; the headlight and also the interior lighting. 2200 w. St Ry Jour—Feb. 2, 1907. No. 82118.

Italy.

Milan-Galarate Electric Railway. Brief illustrated description of the equipment of a railway which has been using continuous-current for the motors with great success. 1000 w. Tram & Ry Wld—Feb. 7. 1907. No. 82588 B.

Electric Traction on Italian Railways. A review of the situation in Italy and the effort to substitute electric traction for all steam railways. 4000 w. Engr, Lond—Feb. 15, 1907. No. 82612 A.

Local Lines.

Electric Traction for Local Lines (La Traction Electrique sur les Lignes de Chemins de Fer D'Intérêt Local). Eric Gérard. Discussion of different systems applicable to railways having strictly local traffic. 3800 w. Serial. 2 parts. L'Electricien—Jan. 12 and 19, 1907. No. 82346 D.

New York.

Transit Facilities in New York. The first of a series of articles describing the nature and progress of transit work in New York City, and the part of the New York Rapid Transit Commission. 3300 w. Engr, Lond—Feb. 1, 1907. Serial. 1st part. No. 82259 A.

Paving.

Paving Between Street Railway Tracks and Rails. B. J. T. Jeup. Read at meeting of the Indiana Engng. Soc. Discusses the types of rails now used, giving arguments for and against them, and discusses the best pavement for city streets. Ills. 1700 w. St Ry Jour—Feb. 9, 1907. No. 82215.

Philadelphia.

Recent Progress in Heavy Electric Railway Work at Philadelphia. Illustrates and describes the work thus far completed in connection with the subway and elevated service. 3500 w. St Ry Jour—Feb. 16, 1907. No. 82437.

Power Stations.

Electric Generating Station of the Paxtang Electric Company of Harrisburg, Pa. Illustrated detailed description of the building and equipment, the transmission lines, sub-station, etc. 4000 w. Elec Wld—Feb. 16, 1907. No. 82430.

New Power Station of the Illinois Traction System at Peoria, Ill. C. S. Johnson. Illustrated detailed description of the building, its arrangement and equipment. 2500 w. Elec Ry Rev—Feb. 23, 1907. No. 82552.

Rapid Transit.

Urban and Suburban Traffic. Lynden Macassey. Read before the Economic Soc. of the British Assn. Discusses the distribution of population by facilities of rapid transit, as a relief for concentrated districts. 4800 w. Engng—Feb. 8, 1907. No. 82469 A.

Side Slot.

Side Slot Point for Conduit Tramways. Illustrated detailed description of the point, invented by A. N. Connett, for conduit tramways in cases where the slot forms the groove of one rail instead of being midway between the rails. 900 w. Tram & Ry Wld—Feb. 7, 1907. No. 82589 B.

Signaling.

Alternating Current Track Circuits in the New York Subway. J. W. Waldron. Illustrated detailed description of the system installed with explanation of the reasons for adopting it. 1200 w. Pro Ry Sig Assn—1906. No. 82485 N.

Spokane.

The Spokane & Inland Empire System. Map and illustrated description of an electric line approaching in character the usual steam roads. Also brief outline of the history of the line. 2000 w. Ry & Engng Rev—Feb. 9, 1907. No. 82203.

Substation.

New Substation of the International Railway Company, Buffalo, N. Y. Illustrated description of the Seneca Street substation just completed. 1800 w. Elec Ry Rev—Feb. 16, 1907. No. 82436.

Tracks.

Track Construction on Interurban Tramways. M. Dubs. The author reports on the results of inquiries made into the various methods in use for track construction on tramways. A large number of systems are described and discussed. Ills. 3000 w. Elect'n, Lond—Jan. 25, 1907. Serial. 1st part. No. 82144 A.

Traction.

Development of Electric Traction (Le Développement de la Traction Electrique). DeValbreuze. Account of the development and present state of heavy electric railroading in Europe and the U. S. Ills. 19000 w. Bul de la Soc Int des Electriciens—Jan., 1907. No. 82344 F.

Wires.

Some Notes on the Breaking of Trolley Wires. P. S. Sheardown. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Discusses the causes, showing that the size of wire is not of importance. Proposes the anchoring of the trolley wire at each suspension, and suggests a simple means of doing this. 2000 w. Elect'n, Lond—Jan. 11, 1907. No. 81739 A.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *w.* Chicago.

Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

Note—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* The Engineering Magazine.

BOOKS RECEIVED.

The Analysis and Softening of Boiler Feed-Water. By Edmund Wehrenfennig and Fritz Wehrenfennig. Translated from the German by D. W. Patterson. Size, 9 by 6 in.; pp. xiv, 290. Figures, 171. Price, $4. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Railway Curve Tables. By R. S. Henderson. Size, 7 by 5 in.; pp. iv, 69. Diagrams, 10. Price, $1. New York: The Engineering News Publishing Company.

A Handbook on Reinforced Concrete, for Architects, Engineers and Contractors. By F. D. Warren. Size, 7 by 4 in.; pp. 271. Tables. Ill. Price, $2.50. New York: D. Van Nostrand Company.

Iron, Steel and Other Alloys. By Henry Marion Howe. Second Edition. Size, 9 by 6 in.; pp. xviii, 495. Ill. Price, $5. Cambridge, Mass.: Albert Sauveur.

Heat and Light from Municipal and Other Waste. By Joseph G. Branch. Size, 8 by 5½ in.; pp. vii, 305. Ill. Price, $3. St. Louis, Mo.: Wm. H. O'Brien Printing and Publishing Co.

Practical Electric Railway Hand-Book. By Albert B. Herrick. Second Edition. Size, 6¾ by 4½ in.; pp. 460. Ill. Price, $3. New York: McGraw Publishing Company.

Marine Engineers: Their Qualifications and Duties. By E. G. Constantine. Second Edition. Size, 7½ by 5 in.; pp. viii, 332. Ill. Price, $2, 5/0. New York: D. Van Nostrand Company. London: Technical Publishing Co., Ltd.

Engineering in the United States. By Frank Foster. Size, 9 by 6 in.; pp. x, 105. Price, 1/0. Manchester: The University Press.

Air Compressors and Blowing-Engines. By Chas. H. Innes. Size, 7½ by 5 in.; pp. 290. Ill. Price, $2, 4/6. New York: D. Van Nostrand Company. London: Technical Publishing Co., Ltd.

The Steel Square as a Calculating Machine. By Albert Fair. Size, 7½ by 5 in.; pp. 81. Ill. Price, 50 cents. New York: Industrial Publishing Company.

Elements of Gas Engine Design. By Sanford A. Moss. Size, 6 by 4 in.; pp. 197. Price, 50 cents. New York: D. Van Nostrand Company.

Practical Pattern Making. By F. W. Barrows. Size, 7½ by 5 in.; pp. 326. Price, $2. New York: Norman W. Henley Publishing Company.

The Copper Handbook. Vol. VI, 1906. By Horace J. Stevens.. Size, 9 by 6 in.; pp. 1116. Price, $5. Houghton, Mich.: Horace J. Stevens.

Elektrische und Magnetische Messungen und Messinstrumente. By H. S. Hallo und H. W. Land. Size, 8½ by 6 in.; pp. xii, 517. Ill. Price, 15 marks. Berlin: Julius Springer.

Combustion and Smokeless Furnaces. By Jos. W. Hays. Size, 9 by 6 in.; pp. vii, 104. Ill. Price, $1.50. New York: Hill Publishing Company.

Text-Book on the Strength of Materials. By S. E. Slocum and E. L. Hancock. Size, 9 by 6½ in.; pp. xii, 314. Ill. Price, $2. New York: Ginn and Company.

Notes on Electrochemistry. By F. G. Weichmann. Size, 8½ by 6 in.; pp. vii, 145. Price, $2. New York: McGraw Publishing Company.

Marine Boilers. By L. E. Bertin. Translated by Leslie S. Robertson. Second Edition. Size, 9 by 6 in.; xxxvi, 658. Ill. Price, $5. New York: D. Van Nostrand Company.

Turbinen und Turbinenlagen. By Viktor Gelpke. Size, 11 by 8 in.; pp. vii, 181. Ill. 31 plates. Price, 15 marks. Berlin: Julius Springer.

Ventilation of Buildings. By William G. Snow and Thomas Nolan. Size, 6 by 4 in.; pp. 83. Price, 50 cents. New York: D. Van Nostrand Co.

Stationary Engineering. By Joseph G. Branch. Size, 8 by 5½ in.; pp. 940. Ill. Price, $3.50. St. Louis, Mo.: Perrin & Smith Printing Co.

Practical Metal Turning. By Joseph G. Horner. Size, 8¼ by 5½ in.; pp. xii, 404. Ill. Price, $3.50. New York: Norman W. Henley Publishing Company.

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THE ENGINEERING MAGAZINE.

PUBLISHED MONTHLY. 140-142 Nassau Street, New York, U. S. A.

AUTHORS AND PAPERS FOR MAY, 1907

LEWIS NIXON *(The Gas Engine for Heavy Marine Service)*—Born in Leesburg, Va., 1861; appointed midshipman, U. S. N., 1878, and on graduation from the U. S. Naval Academy in 1882, was sent by the Navy Department to the Royal Naval College, Greenwich, England; was transferred to the construction corps of the Navy in 1884, and before his retirement from the Navy in 1890, designed the battleships Oregon, Indiana and Massachusetts. Was superintending constructor of the Cramp shipyard, Philadelphia from 1890 to 1895, resigning in the latter year to start, on his own account, the Crescent shipyard, Elizabeth, N. J. On the formation of the U. S. Shipbuilding Company, Mr. Nixon was made a director and its first president; is at present president of the Carbon Steel Company and of the Standard Motor Company, and a director of several other industrial and financial organizations.

H. COLE ESTEP *(The Technical Student and the Engineering Apprenticeship Course)*—Born near Seattle, 1886. Is a student in the department of mechanical engineering at the University of Minnesota. Has been interested in the subject of the present article for some time and, having had extensive intercourse with the students of many of the technical schools of the Middle West and the Pacific Coast, has been able to collect his material at first hand and to base his conclusions on actual experience.

FREDERICK BLOUNT WARREN *(A Railroad University. Altoona and its Methods)*—A regular contributor to the monthly magazines. Writes on a variety of subjects but a great part of his work deals with industrial and engineering topics which he treats in a non-technical, yet accurate and comprehensive manner. His article on the Altoona shops and apprenticeship courses is the result of a personal investigation and all his facts and figures have been passed upon and verified by the department heads of the Pennsylvania Railroad.

H. VON SCHON *(Hydro-Electric versus Steam Power for Industrial Plants)*—Born in Germany, graduating from Berlin in 1869; for thirty years a specialist in hydraulic engineering; several years were spent by him in connection with the U. S. Engineer Corps in surveys of the Great Lakes, but for the last twelve years he has devoted himself exclusively to the designing of hydro-electric power installations. The most important of the many he has planned is that at the foot of Lake Superior, notable as utilizing the largest flow—some 30,000 second feet—while that at Eugenia Falls, Ontario, uses only 80 second feet, but a head of 400 feet. Mr. von Schon has originated a number of valuable features, one of which, the submerged power house, has been incorporated recently in a plant at Patapsco, Md., the entire generating equipment being placed in the interior of the dam, with the spillway water rolling over the power-house roof. He is a member of the American Society of Civil Engineers.

REGINALD PELHAM BOLTON *(Present Practice in the Use of Superheated Steam)*—Born and apprenticed in England; served as assistant engineer at the Edgemoor Iron Works and as assistant to Dr. Erasmus Leavitt; has been in practice in New York City since 1895 on the equipment of large buildings, having designed, within the last few years, the equipment of the Bowling Green offices, the Grand Central Station, the Royalton and Lorraine hotels. He originated the vertical system of electric wiring and duplex-pressure hydraulic-elevator system; has been in charge of the remodeling of the Ridgewood Pumping Station for the City of Brooklyn, before and since its incorporation with the city of New York, from 1896 to 1900; associate member of the Institution of Civil Engineers, member of the American Society of Civil Engineers, and of the American Society of Mechanical Engineers.

H. L. WHITTEMORE *(A Theory of Stores Operation for Machine Shops)*—Born in Milwaukee, Wis., in 1875 and was educated in the schools of that place; spent several years as apprentice and machinist in shops in his home city and in Hartford, Conn.; in 1900, entered the University of Wisconsin and completed the course in mechanical engineering in 1902; became assistant superintendent of the Sullivan Machinery Company of Claremont, N. H., which position he resigned in 1905 to act as assistant to A. P. Hanson of Berlin, Germany, on experimental laboratory work; in 1906 was employed in systematizing in the Control Division of the British Westinghouse Electric and Manufacturing Company, Manchester, England. Is at present instructor in the laboratory of applied mechanics of the University of Illinois.

C. E. KNOEPPEL *(Cost Reduction through Cost Comparison)*—Born in Milwaukee, Wis., 1881. Educated in the Public Schools of Buffalo, N. Y. Spent a year in a technical school in that city. Removed to Oswego, N. Y., and was for two years employed as a moulder in the foundry of the Ames Iron Works. Was employed as draftsman and designer for two years by the Buffalo Forge Company, Buffalo, N. Y., and for one year by the Parkhurst Compound Steam Boiler Company of Oswego. Was then connected with the Department of Expert Systematizing of the Library Bureau, Boston, and has been a student and a specialist in costing methods for six years past. Is at present office manager for Clark Bros. Company, Belmont, N. Y.

TON-MILES IN A TROY
COST LEAST FOR REPAIRS

In measuring the economic efficiency of a freight car, it is the practice to record the number of miles that it travels and the number of tons that it hauls. The two multiplied together give the ton-miles. The total cost of repairs to the freight car is divided by the total ton-mileage, and the quotient gives the cost per ton-mile for repairs. In like manner certain contractors keep approximate records of the cost per ton-mile of hauling done in wagons, both as to wages and as to maintenance and depreciation. If all contractors were to do this, and if every contractor were to begin by owning even one Troy wagon, there would be no other dump wagon in use in less than five years' time. Troys are built to carry as heavy loads as can be piled upon them. The simplicity of the dump mechanism, the use of indestructible steel doors, the use of steel "ironing" throughout instead of castings, and the strongest running gear ever made, make the Troy wagon superior in durability to all competitors. Having been in the wagon making business longer than any competitor who makes a specialty of dump wagons, it is not to be wondered that we have learned now to make wagons that last, nor that we have been keenly alive to the importance of durability as a factor in getting repeat orders for our product. It happens, also, that we make the only sand-tight bottom dump wagon. Its steel doors lap on each other. Send for catalog No. 2 E. M.

THE TROY WAGON WORKS COMPANY
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THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXXIII. MAY, 1907. No. 2.

THE GAS ENGINE FOR HEAVY MARINE SERVICE.

By Lewis Nixon.

It was said some time ago by one of the world's greatest leaders in engineering achievement, that the steam turbine was an intermediate step in power economy between the reciprocating engine and the internal-combustion engine. Now, close following upon the striking enlargement of the use of the turbine for ship propulsion, come indications that this may indeed be only a transitional step, and that the marine power plant may pass on even more rapidly than the land station to the machine of higher economy—the internal-combustion engine.

It is significant that while Mr. Nixon's training and sympathy would justify him in thinking first of naval and tactical advantages, he does not base his faith primarily on the military considerations which were given so much prominence recently by Mr. James McKechnie. He founds it on the solid principles which have always underlain the commercial supremacy of the seas—the ability to meet all conditions of ocean navigation more securely and more economically than any rival. In affording opportunities and a market for the development of the gas engine, its utility to the cargo carriers of the world will far outweigh its advantages aboard the fighting ships of war. And to this Mr. Nixon adds one consideration more—one of the newest to gain recognition as an important factor in industrial affairs—humane regard for the workers.—THE EDITORS.

IT is said of a prominent American statesman that when the pros and cons of expansion were being discussed in a tiresome way, he rose in his seat and said: "But we've done expanded!"

We see much in the press about the possibility of adopting the gas engine for marine propulsion. It is adopted!

Engineers found progress with the steam engine the easier owing to the 15-pounds gain by vacuum, and the fact that the earlier engines were not built to permit of service pressures great enough to make this gain negligible.

The demand upon the steam engine is greater and greater and the last stage is reached in superheating the steam and in the turbine. Steam at 250-pounds pressure is an agent hard to hold in bounds, and the slightest yielding means death by scalding and burning. The engine force of a liner after a trip across the ocean look like battle-scarred veterans.

The turbine requires a very high vacuum for high efficiency and time only will tell how this will work out in service. But even with the best of conditions in steam service—and these conditions have so long been looked upon as necessary evils, that the pitiable life in an engine room receives but little attention—we must still hark back to the man-fired boiler, and it would require a Dante to paint here a real picture of the fire-room inferno.

Horse powers of a thousand in one-cylinder gas engines have been used now for years, and the economy is demonstrated to be superior to the best types of steam engines run under the most economical conditions when newly tested. Many such engines run for months without stopping for repair or overhaul. Simplicity, too, is a feature of the gas engine of extreme importance, and this influences its rapid development in a marked degree.

I know of no fact showing the simplicity more clearly than the general grasp of the automobile engine. This modern miracle of the Twentieth Century, which in comfort gives us on our highways the speeds of a railway train, is having an influence upon the world's progress in that it is bringing about an intimate personal touch with a prime mover and developing an understanding of mechanics which is becoming not only general but popular. The gas engine is easy to understand and control, and hundreds now run them where one can run a steam engine of like power. It helps the farmer cut his wood and thresh his grain and on large farms will soon do the ploughing and reaping.

Many a poor fisherman to whom age has brought waning strength and stiffening joints, finds in the gas motor a ready and easily understood means to continue his usefulness and earning capacity. On suburban lines it gives a flexible and always ready means of transportation independent of a central station and far more economical than electricity in first cost and maintenance. On railway cars it has demonstrated its ability to do as well as the steam-propelled car and it only needs use and further study of the problem to show its superiority.

I am convinced that gasoline and alcohol are the ideal liquid fuels for gas engines for marine purposes on torpedo-boats, destroyers, launches and scouts, and all other war-vessels of not over 20,000 horse power where great speed and endurance are required and weight and space must be reduced to the minimum. This is because they are "liquid primary fuels," to use an apt phrase coined by Commander Willets, U. S. N., and can be used without atomizers or producers, so saving much additional apparatus and being always ready for instant application.

The danger, provided we have a proper installation of the gasoline tanks and connections, is far less than with steam of over 200-pounds pressure. We hear of a great many explosions of steam plants of late, especially where deterioration eats up the small margin possible with extreme demand—but think of the accidents which occur unchronicled!

Without going into the dozens of advantages, for an understanding of which I should advise reading the admirable paper of Commander Willets, U. S. N., read before the American Society of Naval Engineers, I will cite the following as the influences that force the recognition and ultimate almost universal adoption of the gas engine in place of the steam engine on the water:—

1. Simplicity.
2. Less strain on the engine force.
3. Less weight and space for the same power.
4. Greater economy.

There have been so many errors in stating what has been done and will be done in the near future that a short *résumé* is desirable.

In the first place not one, but *ten* torpedo-boats have been produced, of 35-tons displacement, carrying an 18-inch torpedo tube, a 47-millimetre rapid-fire gun and three automatic guns, with a speed of over 20 knots and an endurance of 2,000 miles. In proof that no sacrifice was made in scantling to produce results impossible with steam, a vessel of this type was run across the Atlantic in winter gales.

The auxiliary four-masted schooner Northland, of 3,000 tons deadweight, has a 500 horse-power engine, and the fishing excursion boat Arion a similar engine.

A destroyer has been designed of 625 tons having 12,000 horse power, and of 30 knots speed.

Another scout destroyer has been designed, of 1,800 tons, with 30,000 horse power and an endurance of 3,000 miles at 30 knots, every detail of which is well within the limits of results already proven out.

The producer problem has received the attention of the ablest engineers of the world, as the present wasteful use of fuel with steam cannot continue and the men who give their time and attention to reduce the fuel bill of the world and conserve its latent energy are rendering a service of supreme importance to mankind.

The hard-coal gas producer is now in very general use and is rapidly forcing the steam plant aside, especially in factory plants.

The soft-coal producer is giving good results but must be further developed.

The next important development will be a simple and easily manipulated crude-oil gas producer.

With its coming as a commercial product we shall see the gas engine in future tramps, and with the advent of the first passenger liner its universal adoption on transatlantic passenger steamers will be assured.

Whether the steamer will be made smaller or not is hard to say, but very probably on account of the greater steadiness and the lesser influence of waves the vessels will continue to grow.

One hundred thousand horse power can be installed in the space and on the weight of 45,000 horse power of steam as put on a modern liner. The consumption of crude oil will be about 750 tons per day for such power.

The largest marine engine yet designed on proper proven-out data that I have knowledge of is a six-cylinder double-acting engine, 33 inch diameter by 33 inch stroke, developing 5,000 horse at revolutions less than 200—but far larger units are in use on shore, and their application on water is an easier problem than on land.

THE TECHNICAL STUDENT AND THE ENGINEERING APPRENTICESHIP COURSE.

By H. Cole Estep.

A FRANK STATEMENT OF A PREVAILING ATTITUDE

One of the most direct ways to a satisfactory agreement between two interests is through each one's understanding clearly the other's point of view. The courses and provisions arranged for their technical apprentices by some of the largest engineering concerns have been described in this Magazine by their founders or by those in charge of their administration.* Mr. Estep speaks for an important element of the student body which these courses are designed to attract and enlist. He speaks from intimate, living knowledge of the men around him—their ideas and their attitude. No one, we believe, will be more interested in a frank statement of this kind than the men who have carefully and conscientiously designed and administered the apprenticeship systems of the large employing companies.—The Editors.

THE purpose of this article is to present a frank and intimate view of the present-day attitude of technical students toward the engineering-apprenticeship courses which are offered by practically all of the ranking engineering manufacturers of the United States. If this attitude is one not of sympathy, but of indifference; if college sentiment is turning away from rather than towards the apprenticeship idea—then the continued success of the system is in danger. The apprenticeship idea is fundamentally sound; much money and time has been spent in perfecting it; and now, if success is to be assured, we must be certain of the sympathetic co-operation of the men for whose benefit the system has been designed. Failure to secure this co-operation means that our costly experiments in apprenticeship courses will also end in failure. The success of the system varies directly with the quality of the men entering the courses, and this quality varies directly with the amount of sympathetic interest in the apprenticeship courses existing among the technical students of the country.

The first thing to determine in the investigation is, then, the present condition of student sentiment in regard to the apprenticeship system. Is it one of warm sympathy, or of apathy; does the apprenticeship idea appeal to the majority of the best men in college, the men fitted to become the best engineers, or not; are the courses considered as an opportunity or as a last resort?

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* See "The Training of Apprentices in the Westinghouse Works," by C. E. Downton, Dec., 1903; "An Example of the Modern Development of the Apprenticeship System" (Brown & Sharpe shops) by L. D. Burlingame, Jan., 1904; "Apprenticeship Systems of the Allis-Chalmers Company," by P. W. Gates, Apr., 1904; "Apprenticeship System of the Baldwin Locomotive Works, by S. M. Vauclain, June, 1904; also "Altoona and Its Methods," by F. B. Warren, on page 170 *et seq.*, this issue.

The writer has many friends in the large universities of the middle west and Pacific Coast, and for four years has been intimately associated with the students of the engineering college of one of the largest schools in the Mississippi valley, and his experience is that the attitude of the students toward these courses is apathetic and detrimental to the best interests of the apprenticeship idea. The young man graduating from his technical course generally thinks that the sacrifices involved in serving two years as an engineering apprentice are too great for the benefits to be derived therefrom, and so turns to the apprenticeship course only as a last resort, after he has tried to get a start in every other way and failed. Generally the answer to the question, "Will you take an apprenticeship course?" is: "Not if I can help it, or can get something better." As a whole the student body of American colleges are not sympathetically interested in the apprenticeship idea and only a few of them are attracted to it. While it is true that many good men enter apprenticeship courses upon graduation, and choose wisely, yet it is safe to say that there are three times as many who should take these courses and yet are not attracted to them, but avoid them. This is where the apprenticeship system is failing; it attracts only a few of the best fitted technical graduates, while the majority are not sufficiently interested in the idea to consider it seriously.

We will now turn to the discussion of the reasons for this state of affairs.

One of the first of these is that the courses offered by many firms are too stiff and inflexible. Every man is ground through the same mill, regardless of his individual requirements or previous experience. The resulting dissatisfaction is infectious, and the knowledge of it spreads through the student world much more rapidly than does the testimony of apprentices who are satisfied with their work. To this defamatory advertising, given the apprentice courses by men justly or unjustly dissatisfied with their lot, must be added that which comes from the lips of some of the employees of large engineering firms who seem to take particular delight in discrediting the apprenticeship system of the particular company employing them. I have met a number of them (fortunately there are not many) who pointed with pride to the fact that they had attained their own positions without the necessity of two years at apprentice wages, adding that, anyhow, the apprenticeship course is valuable only to men having a "pull." As is usual in such cases the words of distrust circulated by these men are well-known among technical students, while the testimony of the hundreds of men who have found their courses to be of great benefit is seldom heard.

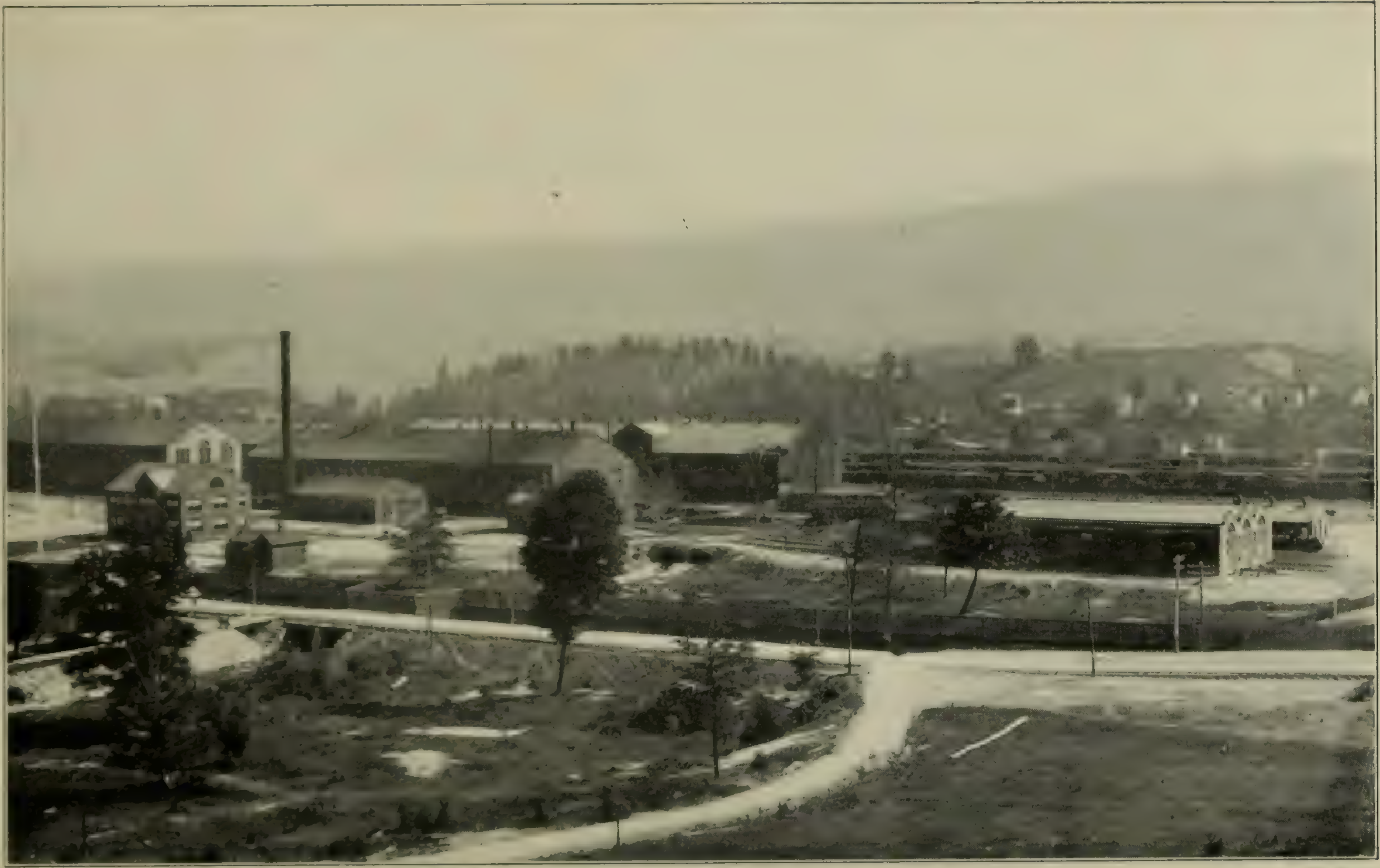
It is unfortunate that there is disseminated among technical students so little *precise* information in regard to the apprenticeship courses, with which most of the unreliable reports now afloat could be contradicted. The average student's idea of the details of the various apprenticeship courses is very hazy. The present-day lack of effort to acquaint the undergraduate with exact knowledge of these courses is a serious mistake in the administration of the system; and the publication and thorough distribution of descriptions of the courses offered by the various companies, at least as detailed as the average college catalogue, would do a great deal toward changing the student's attitude toward the apprenticeship idea. It is customary for the companies to send men to the various colleges to lecture to the students on their apprenticeship courses. This policy is admirable, but the administration of it is poor. The lectures are too general and do not tell the student what he wants to know. I have attended a number of them, and while they were interesting and copiously illustrated talks, they dealt too much with "glittering generalities" and contained extremely little *definite* information. The natural conclusion is that the companies, having something to hide, do not care to have the exact details of their courses known. This, together with the unreliable stories in circulation, causes the prevalent harmful feeling of distrust and skepticism about the apprenticeship idea. A systematic campaign of publicity is needed to remedy matters.

Investigation among technical students reveals, aside from the question of wages, three principal objections to the apprenticeship courses: first, the courses are too long; second, there is no reward at the end; and third, the invention clause existing in many apprenticeship contracts is unfair.

As to the first objection, it is doubtful if the courses could be made any shorter without impairing their efficiency. But much could be done to remove this complaint if more information in regard to the work accomplished during the two or three years was current in college circles. The same is true of the second objection; it too would be practically removed if exact information in regard to the subsequent successes and rewards of the apprentices was more generally disseminated. These two complaints are caused principally by the same careless advertising of the apprenticeship system that was discussed in a preceding paragraph. College men are not to be lured into the apprenticeship system by meaningless generalities and dogmatic assertions, but would easily be convinced by a straightforward presentation of the specific facts of the case. So far as the invention clause is concerned, it would be good policy to abandon it. This contract required of apprentices, to consign *gratis* to the company inventions which may be worth hundreds of dollars, is not fair. Even if the company gives the apprentice the opportunity and time to make the invention, it still must be admitted that, if the invention is of any value at all, it is worth much more than the amount included in the apprentice's wages. Inventions of value made by apprentices should be treated individually and in a businesslike way. The cost of patents and preliminary development should be charged to the apprentice, and then a fair price or royalty should be paid him for his invention. The adoption of this policy would do a great deal to remove the impression, so noticeable among technical students today, that the companies "are out for all they can get" out of an apprentice.

To the average college man, who has spent four of the best years of his life acquiring a technical education at an expense of from $1,000 to $3,000, the pay offered the engineering apprentice seems ridiculously and discouragingly small. This question of wages is the most important and difficult problem that arises in the administration of the apprenticeship system. The problem is by no means solved. It is claimed that the present rate of pay is all that the average apprentice is worth, and that to this he should add the value of the education he is receiving. It is also claimed that the apprentice often takes the time of very valuable men, which must be charged against him. This latter argument has little foundation in fact. The apprentice usually is given a few brief instructions by the foreman or superintendent, and then save for an occasional hint is left to shift for himself. But be this or the other arguments what they may, the fact remains that the present rates and *methods* of paying engineering apprentices are responsible, more than any other one cause, for the lack of sympathy in the apprenticeship courses now existent among the student body of the colleges. Many men are financially unable to stand the expense of an apprentice course. This is specially true of the graduates of colleges in the Western States, and many good men are lost to the apprenticeship courses for just this reason. College graduates are often heavily in debt for their education and it is imperative to them that some paying employment be found. The result is that the apprenticeship course, though it may pay well in the end, is not considered. The first thing to do in remedying matters would be to change the whole system of wages and abolish the repellant and discouraging flat-rate system now so extensively practiced. Apply the same common-sense methods to the apprentice-wage problem that have met with such success in dealing with the wage question in general—that is, abandon the antiquated flat rate and adopt the modern piece-work and premium system. This would be fair to all concerned. If the apprentice had the ability and skill he could then earn as much as the journeyman machinist working in the shop by his side; if not, he would have only himself to blame. In the drawing room and office pay him the average, fair rate based on his *individual* experience and ability. Then charge up to him the legitimate expenses of his course, the waste and breakages, the cost of the instruction and the other items. This system, though requiring time, tact, and judgment to administer, would be well worth while. It would make the apprenticeship course a much more attractive proposition to the man about to graduate from college.

Summarizing our investigation we find that the attitude of the American technical student toward the apprenticeship system is apathetic and not sympathetic; that the principal cause of this apathy is two-fold, first because the advertising of the system is general where it should be specific, second, that the present, low, flat-rate system of wages is discouraging rather than encouraging to the average college man. The thorough practical training acquired in an apprenticeship course is an essential element in every successful engineering career, and it is to be hoped that the present apathetic spirit of technical students will be so transformed that the future history of the engineering-apprenticeship system will be that of continually increasing usefulness.



THE JUNIATA SHOPS, LOOKING FROM THE HILL.

A RAILROAD UNIVERSITY. ALTOONA AND ITS METHODS.

By Frederic Blount Warren.

Academic instruction in the mechanical side of railway engineering serves, at best, as a ground-work on which to base the highly intimate and specialized knowledge of actual practice which present industrial conditions demand of the railway engineer. All railroads have recognized the necessity of especially training young men by contact with actual working conditions before entrusting them with positions of responsibility, and, to this end, several of the more important railroads have established more or less elaborate apprenticeship courses open to graduates of technical schools. The present article describes the system employed by the Pennsylvania Railroad, whose immense shops at Altoona offer a unique opportunity for thorough and comprehensive training.—The Editors.

MORE than 10,000 men are in daily attendance upon the largest railroad university in the United States, which is conducted by the Pennsylvania Railroad at Altoona, Pennsylvania. Altoona is a busy little city of 50,000 persons and for the month of December, 1906, 13,000 men received at that point pay checks aggregating $825,000 from the one corporation which practically controls the destinies of the municipal population.

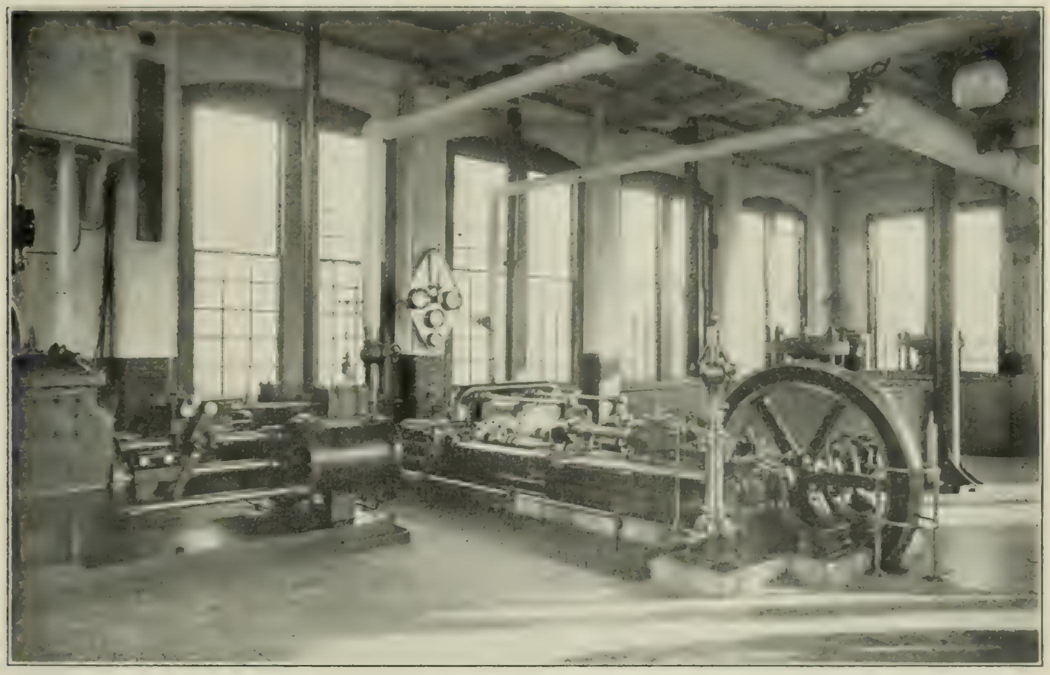
First of all, Altoona is a railroad city, where the industries, clubs, churches and society exist in a railroad atmosphere. It is the home of the largest freight yard in the world, this being 7 miles long from end to end and accommodating a total of 221 miles of track. In one month last year 154,442 cars passed through the town. Dozens of trains, laden with coal, come from the mountain districts every day; the cars are separated and classified and the new-made trains roll eastward. The total movement of freight cars through the Altoona yards in one year was 2,004,603; the average a day is about 6,000 cars Ninety-nine freight trains have been known to come in from the West in a single day of twenty-four hours.

Four important branches of railroad work are quartered and conducted here, affording the student of railroading a more thorough technical training than he could obtain at any other point in the United States. They are: the machine shops, I. B. Thomas, master mechanic, where locomotives are repaired; the car shops, W. F. Eberle, general foreman, where new cars are built and old ones repaired; the Juniata shops, W. H. Bennett, master mechanic, where only locomotives are built and none are repaired, and the South Altoona foundries, E. McLean, general foreman, where car wheels to the number of 900

THE JUNIATA BOILER SHOPS, SHOWING RIVETING MACHINES.

daily are made, as are also general castings for locomotives, cars, and miscellaneous work.

The Juniata plant is the only locomotive shop in the United States owned by a railroad and exclusively devoted to the building of locomotives. The Altoona machine shops are the best known in the country. At the present time they are repairing about 200 locomotives a month. The shops were commenced in 1850, four years after the road was completed over the Allegheny Mountains. Each of the three erecting shops has three longitudinal tracks, two of them have three overhead traveling cranes each, and the third shop has two supplemented by three electrical wall cranes on each side of the shop.



HYDRAULIC PUMPS IN THE JUNIATA SHOPS.

Already one of the best equipped plants in the United States, the Juniata shop increases in size or is improved in some way almost every year, but the following extensions were made in the main during 1902 and 1903. The original structure of the machine shop was 75 by 258 feet, two stories high; erecting shop 70 by 354; blacksmith shop 80 by 306; boiler shop 80 by 386. This shop was extended in length to 722 feet and the runway of its crane was extended 160 feet beyond the end of the shop for the purpose of handling supplies stored in the yard. The blacksmith shop grew to a length of 514 feet and an additional blacksmith shop 80 by 210½ feet has been built. The machine shop has been more than doubled in length, being now 578 feet 6 inches. The erecting shop is now 579 feet 9 inches in length. The boiler house, originally 45 by 70, was enlarged to 45 by 151 feet. The original office building provided space for the care of stores, but in order to provide additional space for both of these departments a new storehouse was erected, 45 by 151 feet 1¼ inches in dimensions. The travelling-crane runways of the machine shop were extended to 60 feet beyond the west end of the shop.

Raw material comes in at one end of the boiler shop and as it passes along through the building is sheared, flanged, punched, assembled and riveted and finally passes out at the opposite end without having gone over the same path twice.

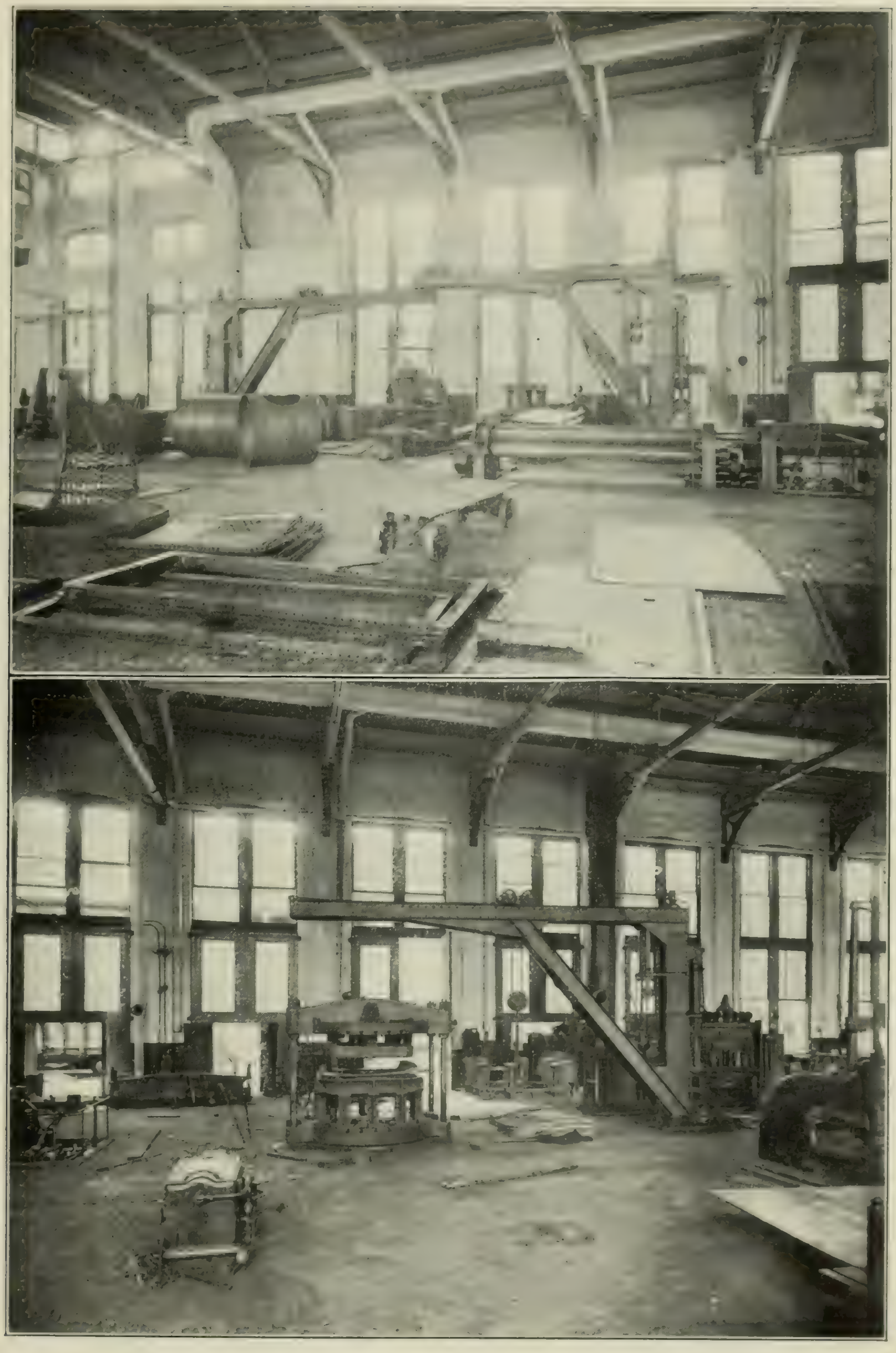
The whole operation is similar to the passing of an earnest student from class to class, each year adding to his store of knowledge till at last he emerges from the shops of learning a completed product.

Upon completion the boiler goes into the erecting shop, the end of which is directly opposite that of the boiler shop. The blacksmith shop is beside the latter. From the former the frames and forgings enter the machine shop, which occupies the same relative position to it as the erecting shop does to the boiler shop. The lay-out of the machine shop is such that the forgings are finished as they pass through without going over the same path twice, and they reach a completed stage at about the center of the building. The cylinders and other castings enter the machine shop from the opposite end, and after going through the various machining operations they reach a completed stage where they meet the frames and other forgings.

From this point the parts go in company through a side door to the erecting shop, and are there met by the boiler which has come in from the boiler shop. In one section of this shop the wheel centers are turned and bored, the axles and crank pins are turned, the tires are shrunk on, and the wheels completely assembled. Lighter machine work, such as making bolts, pins, staybolts, main and parallel rods, valve-motion work and the like, is done on the second floor of the machine shop, but this does not affect the general plan of things.

Locomotives to the number of 275 comprise the annual capacity of the Juniata shop. At the present time about 1,462 men are employed, exclusive of the heads of departments, together with the clerks and all others employed by the month, and are distributed as follows: boiler shop, 490; machine shops, 511; blacksmith shop, 298; erecting shop, 201; yard, 43; carpenter shop, 30; boiler plant and engine room, 33; paint shop, 24; scale department, 12.

While no further extensions are under way at the present time, the lay-out of the shops is such as to enable the main shop buildings to be

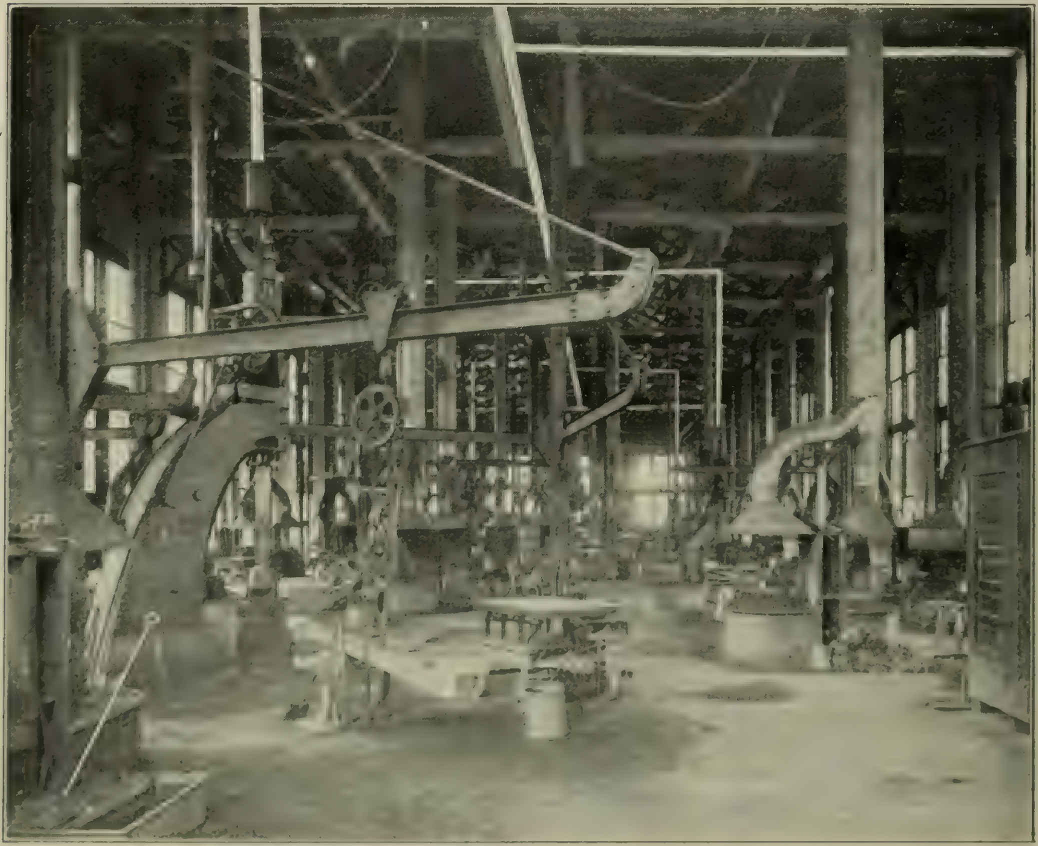


IN THE BOILER SHOP.

Below, the flanging press; above, the bending rolls and hydraulic punches.

duplicated, thereby affording possibility of an output of 500 to 600 locomotives a year.

From all over the Pennsylvania system east of Pittsburg cars and locomotives by the thousand are sent to the machine shops to be repaired, and in consequence the total floor area of nearly 80 acres in the shops is none too large, even without the heavy rushes that frequently occur.



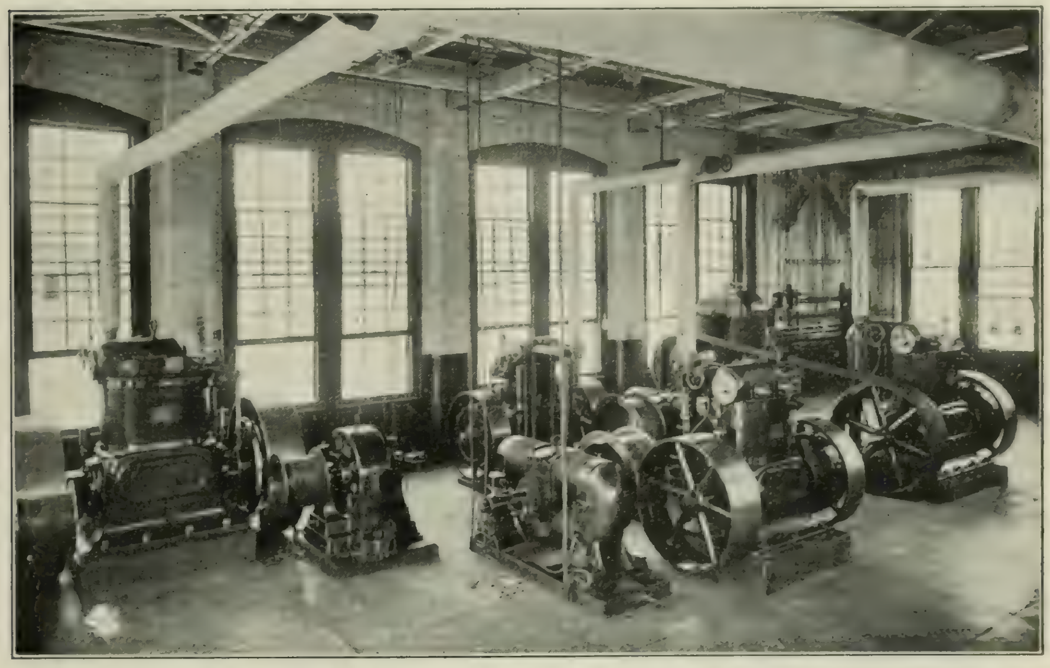
BLACKSMITH SHOP, WEST END; JUNIATA SHOPS.

To take advantage of these extraordinary facilities students gather and learn railroading from the bottom up. "Silk stockings" find no places for them; there is the ultimatum of work or departure. And it is dirty, grimy work that severely tests the measure of young men. However, a graduate is splendidly equipped as a result of his apprenticeship.

The young men who come to take a course in the shops are called special apprentices, and they are put to work in the blacksmith, tool, wheel, tank, and boiler departments; then they learn how to keep accounts in the shop-clerk's office. Still more time is spent in the drawing room under the supervision of Axel S. Vogt, the mechanical engineer of the road, or in the laboratory. Throughout the course the apprentices are carefully watched and directed. A record of every man's performance is kept. The only educational requirement for admission to the course is that the applicant be a graduate of a technical school or college. There are four years in the course, divided as follows:

Erecting shops	6 months
Vise shop	3 months
Blacksmith shop	2 months
Boiler shop	2 months
Roundhouse	4 months
Shop-clerk's office	2 months
Test dept.	5 months
Machine shop	6 months
Air-brake shop	2 months
Iron foundry	2 months
Car shop	6 months
Firing on road	3 months
M. P.'s office	2 months
Drawing room	3 months

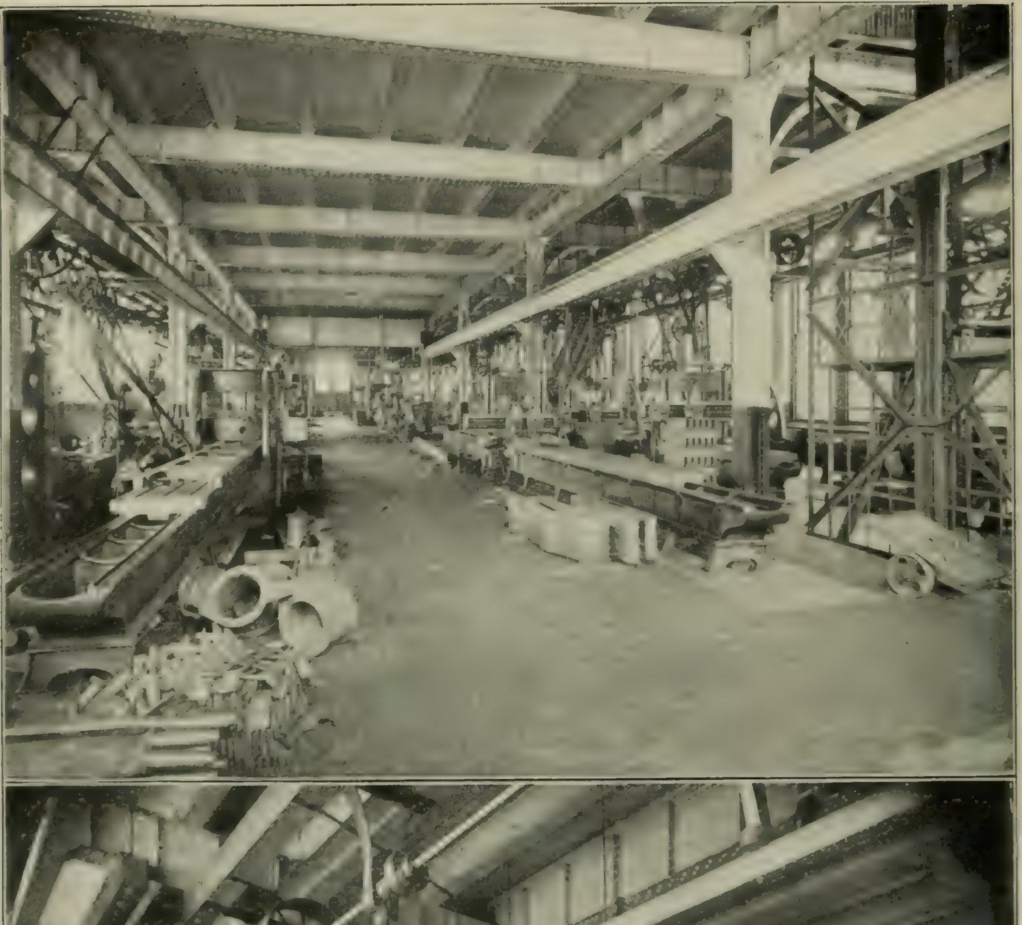
No text book is used, nor is any special reading required in the special apprentice system, which has been in operation since 1871. The superintendent of motive power is in charge of the course.



ELECTRIC PLANT, HYDRAULIC AND ELECTRIC BUILDING.

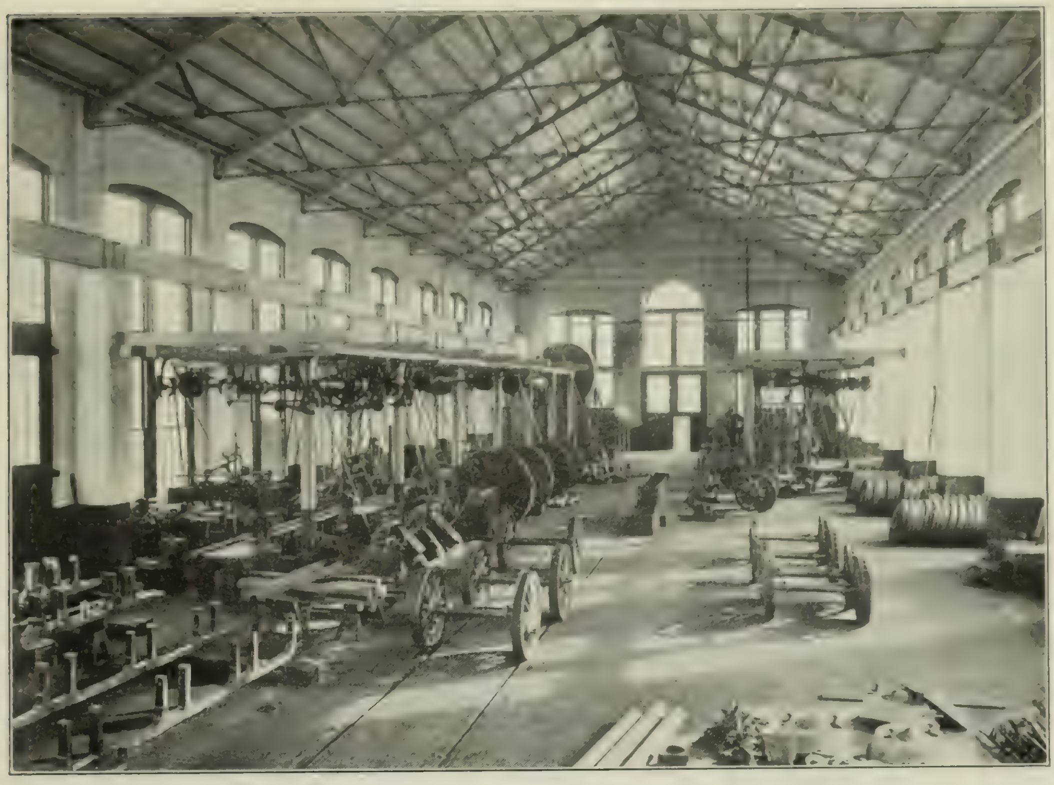
Any man available to rise to the highest positions usually goes through the grades of inspector, assistant master mechanic, assistant engineer of motive power, assistant road foreman of engines, road foreman of engines, master mechanic and superintendent of motive power. Naturally enough the line of promotion is not fixed by any rigid rule.

Many bright young men of good parentage, having passed through college and being vouched for by one of the general officers of the company, put on jumpers and spend several years in the shops in order to fit themselves for higher work in the railroad service. And that



FIRST FLOOR OF THE JUNIATA MACHINE SHOPS.

The lower view shows the west end; the upper, the east.



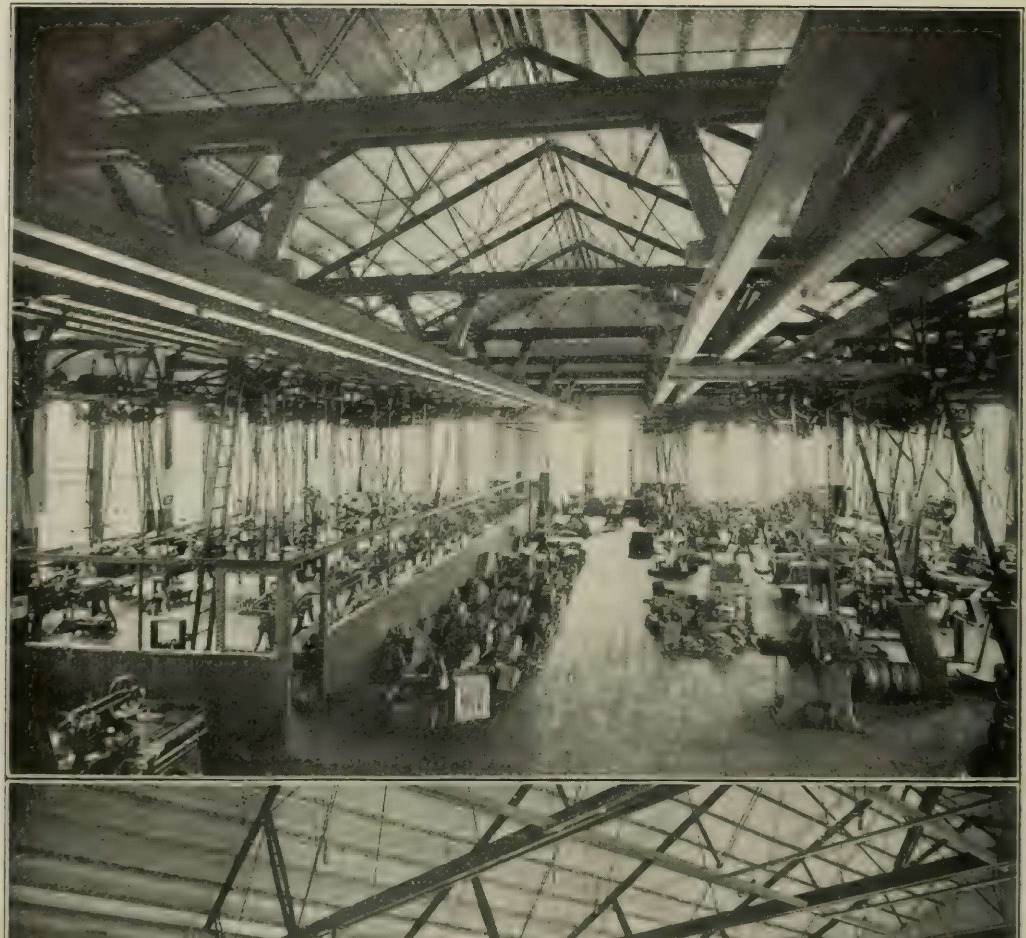
ERECTING SHOP, WHEEL AND AXLE DEPARTMENT.

they may attain their ambition is shown by the case of Frank Thomson, a former president of the system, who was a graduate of this manual-training school. It was in the Pennsylvania Railroad shops that he became thoroughly conversant with railroad construction.

Students of railroading at Altoona learn that to take care of the steady flow of traffic, increasing day after day, week after week, a remarkable machinery of yard management and train manipulation has of necessity been developed. The intricacy of it causes dizziness in the head.

Smoke-hung, dirty freight trains in excess of fifty steam daily into the yards, shunt their cars along the tracks, where new trains are made up by a force of twenty-five yardmasters and assistant yardmasters who have charge of the work. Under them are hundreds of clerks, car makers, lever men, switchtenders, enginemen, conductors and brakemen.

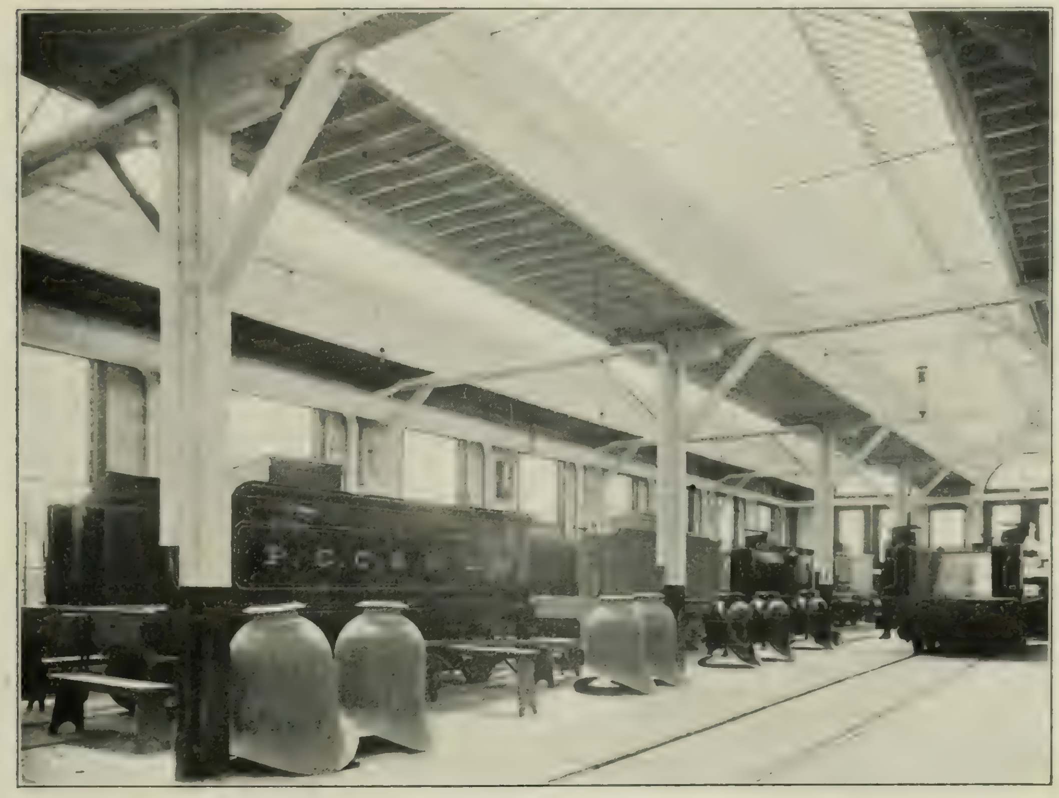
In the department of the principal assistant engineer are gathered from all points on the lines East—this meaning Pittsburg—young civil engineers eligible for promotion to the position of assistant supervisor. These youths, after completing their education at technical schools and colleges, have entered the service of the company either in the construction department or in the offices of division superin-



THE SECOND STORY OF THE MACHINE SHOP.

The east end above; the west below.

tendents. As they show fitness they are sent to Altoona, where a record is kept of their age, education, and previous experience. They become acquainted with the general routine of the maintenance-of-way work and with the Pennsylvania methods of operating a railroad. From this force men are appointed assistant supervisors. Then in order of seniority they become supervisors, assistant engineers, superintendents.



THE PAINT SHOP.

There is nothing for which the increasing prosperity of the United States has created a greater demand than trained railroad men. As there is no railroad school or college in the United States, Altoona is the best substitute for such institutions and it has grown to vast proportions and become, in reality, the *alma mater* of railroad men. No like parallel is presented by any other city. Altoona is the last word in practical railroad education. After completing the course two things are still to be gained, things that come gradually to men in the making—executive experience and equilibrium.

In Altoona are gathered a number of the principal operating officials of the road and with them their families. At best the city is not a garden spot, and a pressing problem proved to be the arrangement of social facilities for the railroad employees. Therefore, just as they would set about the building of a new roundhouse or car shop, in the same businesslike manner, the railroad officers attended to making conditions as agreeable as possible for the men. The Altoona cricket club, which had been in existence for many years, was converted into a club for the officers of the maintenance-of-way, motive-power, and other departments, and the special apprentices. The club is located on a high hill which rises far above the valley in which run the railroad tracks. Golf links, tennis courts, indoor games, and all of the appointments of a well-regulated club are provided. For the men employed by the railroad company the Y. M. C. A. has club facilities. and nowhere has such a branch of this organization been more thoroughly developed.

RECEPTION HALL OF THE ALTOONA CRICKET CLUB.

During the latter days of February the city of Altoona added to its educational facilities a railroad high school, which is the first institution of its kind in the United States. Its progress may mark the beginning of a new era in education, if other industrial corporations see the advantages of forming such a working partnership with the public schools as the Pennsylvania Railroad has made in Altoona. The industrial department of this high school is fully equipped and all bills are paid by the railroad company. The department has nothing in common with manual training. A four-year's course is planned, beginning with mechanical drawing and ending with machine design. The creation of the department is the result of a desire on the part of the railroad to discover a way to combine its needs for trained employees with the aim of the public-school authorities to turn out young men ready to earn a living.

A drawing room, carpentry shop, forging room, a wood and metal-working machinery department—all equipped with modern tools—together with the expert instruction to be provided, will enable the school to give students advantages heretofore enjoyed only by pupils of the best technical schools.

Graduates of the Altoona high school will be fitted to go directly into the Pennsylvania shops on a footing between the regular apprentices, who, as a rule entirely lack training, and the special apprentices who are graduates of technical schools. The railroad's return on its investment is expected in the form of better educated employees.

The Pennsylvania does not alone bear the indebtedness to Altoona for thousands of its principal men, for many other railroads have drawn operating officials from among those who have learned the art of transportation here. When the International Railway Congress met in the United States two years ago one of its chief purposes was to visit the "greatest railroad town on earth."

HYDRO-ELECTRIC POWER VERSUS STEAM FOR INDUSTRIAL PLANTS.

By H. von Schon.

II THE DEVELOPMENT OF WATER-POWER AS A COMMERCIAL ENTERPRISE.

IN a preceding article, the first of this series, hydro-electric power was arrayed against steam power by comparisons of source, agencies, operation, and economies. These represent the evidence on which must be based the claims for the superiority of electric motive power in industrial establishments, and for water power as the primary source for these and central plants; whether or not the case has been made out rests with the reader.

Practice is founded on theories; but, no matter how logical and conclusive may be the deductions, their application alone carries conviction. The Niagara hydro-electric development may properly be cited as representative of all that has been said of electric-power application; here the electric current grinds flour and operates elevators; wood is reduced to pulp and manufactured into paper; soda ash, bleaching powder, carborundum, calcium carbide, aluminum and other products are manufactured by electric current; ship building, car wheels, structural steel, steel and malleable-iron casting plants, all employ electric power; a malt house uses 300 horsepower; a bakery and an ice plant are driven by electric current, and this power operates the Niagara, Buffalo and extensive suburban traction systems, and lights several cities and thousands of houses. This is an illustration of the central hydro-electric plant, furnishing power to shops, mills, and public plants, without restrictions of location or distance and independent of the uncertainties of fuel supply, at a cost far below that of the most economical steam-power service.

It is true that the Niagara hydro-electric development is the largest in existence; but this fact does not disqualify the comparison, as it differs from other existing plants or as yet undeveloped opportunities only in volume of output. The unit cost of this output, up to its present scope, is no lower than can be and is secured under normal conditions with the smallest developments.

The following is a partial list of American cities which are served with hydro-electric power of 1,000 horse power and more, and the distance from the point of development. Almost all of these services have been created during the last decade:—

City.	Horse Power.	Miles.
Montreal, Can.	46,000	85
St. Catherines, Can.	8,000	22
Hamilton, Can.	8,000	35
Port Arthur, Can.	10,000	22
Quebec, Can.	3,000	7
Toronto, Can.	7,000	80
Niagara, N. Y.	55,000	..
Buffalo, N. Y.	40,000	23
Albany, N. Y.	32,000	40
Massena, N. Y.	35,000	3
Hudson, N. Y.	3,000	38
Utica, N. Y.	5,400	12
Rochester, N. Y.	3,200	56
Lewiston, Me.	3,000	20
Portland, Me.	2,660	13
Sanford, Me.	2,000	9
Manchester, N. H.	5,370	14
Concord, N. H.	1,000	4
Montpelier, Vt.	1,670	..
Attleboro, Mass.	1,260	..
Springfield, Conn.	3,780	6
Hartford, Conn.	4,000	11
Easton, Pa.	1,500	4
Lancaster, Pa.	1,000	..
Grand Rapids, Mich.	3,000	40
Kalamazoo, Mich.	2,000	20
Muskegon, Mich.	1,000	15
Jackson, Mich.	1,800	18
Cheboygan, Mich.	3,000	6
Buchanan, Mich.	2,000	18
Sault Ste. Marie, Mich.	50,000	2
Minneapolis, Minn.	7,500	10
St. Paul, Minn.	4,000	25
Joliet, Ill.	4,500	8
Richmond, Va.	12,000	28
Petersburg, Va.	3,000	3
Fredericksburg, Va.	4,000	3
Roanoke, Va.	3,000	13
Montgomery, Ala.	3,500	30
Salem, N. C.	2,000	14
Augusta, Ga.	3,600	2
Athens, Ga.	2,200	..
Columbia, S. C.	7,000	..
Anderson, S. C.	3,000	10
Rock Hill, S. C.	4,000	..
Salt Lake City, Utah.	10,000	37
Logan, Utah	2,800	40
Butte, Mont.	10,000	65
Helena, Mont.	12,000	11
Colorado Springs, Colo.	1,800	25
Pocatello, Idaho	1,200	30
Seattle, Wash.	8,000	38
Tacoma, Wash.	1,400	45
Spokane, Wash.	6,000	42
San Francisco, Cal.	15,000	220
Sacramento, Cal.	4,000	23
Los Angeles, Cal.	10,000	83
Fresno, Cal.	2,000	56

There are now under construction hydro-electric developments which are reported to represent an aggregate capacity exceeding half a million horse power, or about as much as is represented in the list here quoted, and nearly one third of these developments are located in the Southern States. The increase of water-power development in the United States from 1890 to 1900 was, according to the Census, from 1,263,000 to 1,727,000 horse power, and it may be expected that the end of the present decade will show an aggregate of two and a half million horse power of developed water power. It goes without saying that almost all this entire increase will be represented by hydro-electric output. No better evidence need be presented to sustain the claim that hydro-electric power will displace steam for central plants wherever practicable, which actually means that, sooner or later, every available water power will find its utility as a source for hydro-electric power service.

It is not the purpose to enlarge unnecessarily upon this topic by presenting any statistics of the growth of the application of hydro-electric power in industrial plants; the very list of central plants gives ample evidence of this and a few typical examples will substantiate all that has been claimed for electric motive power as against steam in shop and mills.

Of the more important shops in the United States where electric power was first introduced the Baldwin Locomotive Works in Philadelphia are among the most widely known. It was there applied, in the words of E. H. Sanborn, (Twelfth United States Census) :—

> "First in the erecting shop for driving two 100-ton cranes, whereby an immediate saving of 80 men was effected. In the wheel shop the common labor force was reduced from 40 to 6 men; the time for reloading a lathe was cut down from 30 to 5 minutes and the total saving in power in that shop was estimated at 50 per cent. In the framing shop the laboring force was reduced 60 per cent. The fuel economy, involving a possible reduction of $120.00 per week, was the smallest item, as the saving in labor was stated at $1,800.00 per week, while the increase in output was large."

This typifies the experience of all iron, steel, bridge and machine shops where the electric current displaces steam.

Pulp and paper plants are equally benefited; so are cotton and textile mills. Typical cotton mills in the Southern States are those at Columbia and Pelzer, S. C., the first using 1,400, the latter 3,000 horse power. At the Pelzer mill the saving in the first cost of shafting and belting, as compared with a similar older plant driven by steam power, reached $10,000, while the increase in the quality and quantity of the output was very marked. One of the New England cotton mills at Taftville, Conn., has been operated for some years with hydro-electric current; two motors of 350 horse power each drive one thousand seven hundred looms, furnish one thousand two hundred incandescent lights, and operate an electric road from the town to the mill and an electric locomotive hauling freight from the steam railway tracks a mile distant.

A marked effect of electric *versus* steam power is reported from the Government printing office at Washington, D. C. At the date of the report of Mr. W. H. Tapley, in 1900, the office had a connected load of 575 electric horse power for printing presses and 125 horse power for elevators. Mr. Tapley reports an increase of 15 per cent. in the output of the press room, and states that during three years, the office running 24 hours daily during Congressional sessions experienced not a single hitch or delay due to trouble with motive power.

Volumes of similar evidence could readily be collected, but the purpose of this article is to examine specifically the hydro-electric development as a commercial enterprise and to reply to the natural question "will it pay?" by outlining a safe and practical method to find this answer. The first inquiry should always concern the probable application of the output—that is, it should include full investigation of the available market, its proximity to the power source, the amount of power in service, the probable increase by existing plants in response to inducements in price; the cost of power now in use, the hours of service, any conditions favoring location of new industries, and, finally, the sentiment of power users toward the change.

If power is to be obtained for an individual enterprise, this represents the nucleus of the market; in that event, the point is settled to this extent and the search need be extended only as to the marketing of whatever surplus power may remain available, in which case it becomes generally a matter of selecting the most remunerative service first. This discussion will, therefore, treat chiefly of the function of the central plant which, in the large majority of cases, becomes the legitimate and most promising scope of the development.

An available market exists in practically every town of the land, and the opportunity to supply it is almost as universal. Few communities are without industrial plants utilizing power; laundries, printers, barbers, hotels, butchers, saddlers, all have now-a-days power-driven machinery—fans, elevators, pumps. These may appear trivial in the category of market, but on closer investigation will be found to be exceedingly remunerative; in fact, it always is, and rightly should be, the user of the small power unit who pays, and can afford to pay, the best price for the service, as his necessities are too small to warrant individual plants. Wood-working shops of all descriptions use more or less power; the practice of utilizing shavings and cuttings for boiler fuel can readily be shown to be expensive when compared with the cost of electric power; machine shops and iron works of all kinds must employ power, and so do knife, scissor, corset, knitting, shoe, textile, woolen, paper, carriage, flour and grist mills and all other manufacturing establishments. And then there are the public service plants, water works, street and domestic lighting, and traction.

The first step to be taken is to ascertain what establishments are using power and the amount and hours of service, which, when tabulated, will represent the existing available market and the load factor. This latter is one of the most important features of market conditions; the total power used may, for instance, amount to

1,000 horse power, but its distribution throughout the 24-hour day may show that only half of this is in actual service at any one time, and that perhaps 500 horse power would supply all the power used. The daily required output would be 500 x 24 = 12,000 horse-power hours, but the actual power used may only be 9,000 horse-power hours, in which case the daily load factor is 9,000 ÷ 12,000, or 75 per cent. This investigation may be extended to the yearly output, which for this market would be 500 x 24 x 308 = 3,696,000 horse-power hours, Sundays and holidays being excluded, while the power used may amount to only 2,217,600 horse-power hours, representing an annual load factor of 60 per cent.

The importance of this market investigation is at once apparent, applying as forcibly to the planning of a power plant as it does to any other commercial enterprise which purposes to supply a certain demand. No set of business men would entertain the building and equipment of a shop or mill for an output twice as large as the apparent demand or market; the consideration of the probable increase of the market is, of course, another matter and, within conservative limits, applies to power plants as it does to other industries.

The next important step, after market conditions are known, is to gain all reasonable assurance of securing the whole of it, or whatever portion can be obtained; to this end power consumers must be conferred with, and if they are operating steam plants, they will generally at first belittle the advantages of changing to electric power; most frequently it is claimed by them that their power is very economical, that they cannot afford to put their steam plants out of commission; many have to use steam for heating purposes and it is difficult to convince them at first that even then the amount saved on power cost will more than cover the expense of steam heat, while they will secure the many other benefits which come to their establishments with electric power substituted for steam. In addition to negotiating with private consumers the public-service opportunities must be dealt with by securing franchises to do business in the town, to set poles and to carry electric lines and, finally, to contract with the town for the lighting and pumping power service.

Having ascertained the amount of power which can be marketed, the price which can be obtained for it should be determined. Broadly speaking, electric power is worth as much as steam power, as even then the consumer secures many advantages which represent savings, such as cleanliness, safety, independent shop and machinery arrangement, speeding of tools, increased output, etc.

A searching investigation of the cost of steam power has recently been carried on in Ontario in connection with the work of a hydro-electric commission organized for the purpose of perfecting a plan of furnishing hydro-electric power by Government aid to the communities of that Province. Aided by the Government machinery, the experts enjoyed rare opportunities to secure authentic data concerning this subject, and the findings are especially pertinent to this discussion. I quote from the Commission's third report, rendered September, 1906:

> "In order to institute a comparison between the cost of electric power and the cost of power generated by steam, the following table has been compiled after a careful study of data available in technical journals, and also from data collected by the Commission's engineers in various towns within the district under consideration. The capital costs have been compiled from information supplied by various makers of engines and other machinery. The table represents average working conditions and assumes a high-class installation."

STEAM-POWER PLANTS.

SHOWING CAPITAL COSTS OF PLANTS INSTALLED AND ANNUAL COSTS OF POWER PER BRAKE HORSE-POWER.

Size of Plant, H.P.	Engines, Boilers, etc., Installed.	Capital Cost of Plant per Horse Power Installed. Buildings.	Capital Cost of Plant per Horse Power Installed. Total.	Annual Cost of 10-hour Power per B.H.P.	Annual Cost of 24-hour Power per B.H.P.
CLASS I. Engines: Simple, Slide-Valve, Non-Condensing. Boilers: Return-Tubular.					
10	$66.00	$40.00	$106.00	$91.16	$180.76
20	56.00	37.00	93.00	76.31	151.48
30	48.70	35.00	83.70	66.46	131.68
40	44.75	33.50	78.25	59.49	117.74
50	43.00	31.00	74.00	53.95	106.46
CLASS II. Engines: Simple, Corliss, Non-Condensing. Boilers: Return-Tubular.					
30	$70.70	$35.00	$105.70	$61.14	$117.70
40	62.85	33.50	96.35	55.50	107.10
50	59.00	31.00	90.00	50.70	97.73
60	56.00	30.00	86.70	47.42	91.34
80	50.00	27.50	77.50	43.86	85.41
100	44.60	25.00	69.60	40.55	79.19
CLASS III. Engines: Compound, Corliss, Condensing. Boilers: Return-Tubular with Reserve Capacity.					
100	$63.40	$28.00	$91.40	$33.18	$60.05
150	53.70	24.00	77.70	29.83	54.63
200	50.10	20.00	70.10	28.14	51.72
300	45.90	18.00	63.90	26.27	48.83
400	43.55	16.00	59.55	24.84	46.12
500	41.25	14.00	55.25	23.73	44.21
750	40.50	13.00	53.50	23.56	44.02
1,000	39.00	12.00	51.00	23.26	43.71

NOTE. Annual costs include interest at 5 per cent., depreciation and repairs on plant, oil and waste, labor and fuel (coal at $4.00 per ton). Brake horse power is the mechanical power at engine shaft.

SHOWING THE EFFECT OF THE ANNUAL COST OF POWER BY A VARIATION IN THE PRICE OF COAL OF ONE-HALF DOLLAR PER TON.

Size of Plant, H.P.		Steam. 10-hour.	24-hour.
10	Simple Slide-Valve Engine.	$6.14	$13.47
20		5.25	11.56
30		4.71	10.35
40	Simple Automatic Non-Condensing.	3.56	7.84
50		3.37	7.41
60		3.26	7.16
80		3.15	6.97
100		3.12	6.87
150	Compound Condensing.	1.75	3.85
200		1.69	3.71
300		1.62	3.60
400		1.56	3.44
500	Compound Condensing; Water-Tube Boilers.	1.39	3.05
750		1.39	3.05
1,000		1.39	3.05

This, it will be noted, quotes the cost of brake horse power at engine shaft, which must be transposed into effective working power by allowing for the loss in mechanical drives, and even then the price is representative only for a 100-per cent. load factor.

In units up to 50 horse power with 10-hour service the cost with $2.50 fuel is rarely less than 5 cents per horse-power hour, and generally much higher; the output of plants of 50 to 100 horse power may be 4 cents, and of larger installations of high efficiency from that down to 2 cents per horse-power hour.

For 10-hour service on a fluctuating load the value of electric current in a market of favorable steam-power conditions is from $25.00 to $40.00, depending on constancy of load and maximum demand, while that for 24-hour service is from $35.00 to $50.00, governed by similar conditions. The most serious power competition is found in markets where natural gas is available for fuel, when steam-power output of 250 horse-power units may be reduced in cost to 1½ or even 1 cent per horse-power hour.

After the available market has thus been thoroughly analyzed the investigation of the power opportunity itself may be taken up, along such general lines as will establish the reliability of rights and privileges, the available output, and the cost of developing and delivering this at the market.

In order to secure control of a power site, options are obtained on such lands as include a favorable location for plant and, if necessary, of the flowage right above it. The Federal Government exercises control of all navigable waters, which include most of the large rivers, and permits or licenses must be obtained from the United States War Department to enter upon such rivers for purpose of development. The policy of the United States Government is distinctly favorable toward the commercial exploitation of these resources, exacting only such reasonable control and supervision as the larger interests of navigation demand. An application addressed to the United States engineer officer in charge of the district, setting forth the purpose and program, will generally secure the privilege asked for. In many sections the county and State authorities exercise some control over erection of dams, requiring the filing of plans and compliance with laws regulating the lumber interests and the protection of fish. The riparian owner can enjoy only the use of the water without retarding, diminishing or diverting the same from its natural channels to the detriment or loss of any other riparian owner or of the State. These limitations of statutes, and the titles to the lands required, deserve competent legal examination before the project of development receives serious consideration.

In many of the States laws have been enacted extending to water-power developments the rights of "eminent domain," by which flowage lands can be acquired on valuations fixed by legally constituted boards of arbitration, but it is most generally preferable and feasible to obtain the flowage easements without title to such lands as will form part of the pond above the development site. The lands required for the works proper should be owned in fee.

After these proprietary conditions have been established the physical examination of the water power *per se* should be undertaken. It is essential to ascertain the amount of available power, the feasibility of harnessing it economically, and the cost of doing so.

The investigations, up to this point, have rather been of the character of generalities, each of them within the scope of the well informed business man's abilities, but at this stage it will be most prudent to select the proper man for the business, that is the engineer.

The first report on the feasibility of development—the available output and its cost—should be made by an expert, a specialist in hydro-electric power engineering. The land surveyor can competently run the levels and ascertain the fall, the experienced civil engineer design a dam and canal, the hydraulic engineer measure the flow and design pressure lines and perhaps turbines, and the electrical engineer the generators and transmission line; but none of these is equipped to compass the entire subject, which is strictly the field of the engineer who devotes himself largely to the study and practice of the combined branches entering into this subject, which is rapidly becoming a specialty. Upon this report, and upon the conclusions arrived at as to market conditions, the project is to be financed; it is, therefore, this first report which is, beyond all doubt, the most important link in the chain.

To find the available flow, so-called—that is, the supply which may be safely accepted as the basis for the output that may be contracted for—is perhaps the foremost of the many important facts to be covered in this report, and, at the same time, the one which is most frequently in error.

The determination of available flow cannot be based upon a measurement or two; on the contrary, all the characteristics and conditions which influence stream flow must be investigated in order to secure an adequate knowledge of its fluctuations. A period of ten or fifteen years should be studied, the monthly and annual precipitation during this period in the drainage area under consideration should be ascertained, and from these data the dry, normal, and wet year and the corresponding flow determined. How this question is solvable will appear in the next article.

When these data are graphically projected and analyzed the otherwise bewildering conditions will appear as an open book, even to the layman, disclosing the periods, duration, and repetition of low, normal, and high flow, and point to the sought-for standard.

Hydro-electric developments should no more be based on the low than on the high flow, but on some stage between the low and normal in which the deficiency of the former can economically be raised to the highest point in the latter, by means of supply from storage or by auxiliary plant, to such an extent, measured by cost, as the value of the output in the available market will warrant.

Even at the risk of frequent repetition it must be pointed out that this individual point—the determination of the flow to be accepted as a basis for the development—is the keystone of the structure, and that the solution of the problem lies not within the scope of the dilettante at this business. Over-estimation of the flow is responsible, more frequently than any other cause, for the commercial miscarriage of hydro-electric projects. The fact that they appear to be based upon what is very generally, though erroneously, considered an unreliable factor is among the chief reasons why this class of enterprises does not as readily command the confidence of business men as others. When hydro-electric propositions receive the competent consideration which is generally secured for industrial undertakings there is no such uncertainty; and, when endorsed by authorities on the subject, they represent invariably most satisfactory investments.

Next to market and output comes the determination of the cost. For this purpose the character of the development, type of structures, power units, generating and transmission equipment, all must be fixed upon; the works must be designed and estimates made of the cost of each construction and equipment feature. It is needless to state that the designer of such a plant must be experienced in this line of work; every situation calls for its own peculiarly fitting development program, and the structural types of works are to be largely determined by local conditions of topography, geology, available materials, transportation, climatic data and a number of other influential conditions. No two such plants are exactly alike if treated most economically for the best results. Which is the most advantageous dam location; whether the available head shall be accumulated at one point or whether a portion of it may be secured more economically by diversion to a lower site; what type of dam is the most suitable; whether the water shall be carried to the turbines by canal, flume, or pipe; what is the best location for the power station; how the turbines shall be placed, whether in open penstocks or in cases; whether horizontal or vertical installations will give the best service; what are the proper units as to capacity and speed—these are only a few of the problems to be solved by the designer of such a plant, and even the merest tyro at this business will readily appreciate that between the right and wrong on any of these subjects there is probably a matter of thousands of dollars saved or wasted—if, indeed, a mistake does not perchance involve the ultimate practicable success of the entire project.

For instance, the choice of the type of dam, generally one of the costliest parts of the plant and largely its chief reliance for safety, certainly calls for broad experience. For want of this and of original resourcefulness, the massive, solid masonry dam still holds almost absolute sway, though the most costly type and difficult of proper construction. To resist water pressures by weight of mass is, however, not the only solution of the problem, nor the most economical one, as the modern development of concrete-steel and its application renders it practical to sustain safely any pressures by comparatively light structures so designed that the weight of the very material which threatens its safety is utilized to counteract this destructive force. But it is not the purpose to treat of the engineering phase in this article; that subject will receive special attention in the future; suffice it to say that what has been here pointed out as to one part of a hydro-electric plant is true of all the numerous features, from the dam to the sub-station of the transmission line at the point of delivery.

When the cost of the output has been established, it should show that of the physical works by which the hydraulic energy is concentrated for conversion into mechanical work, of the generating equipment, and finally, of the transmission plant. The output should be expressed in electrical units, as that will be its commercial measure, and, in its determination, the efficiencies of turbines, generators, transformers, and transmission lines should be taken at their practical working values, rather than at such ratios as are found in trade catalogues or are even frequently expressed as guaranteed in specifications. Carelessness in this regard will easily result in showing an output 10 or 15 per cent. in excess of the actual, and very frequently such percentage represents the determining margin for a safe or unsafe enterprise. Nor should the cost estimate fail to add the contractor's profit and a liberal allowance for engineering and emergencies.

And now the project may be analyzed as to its commercial value. The capital investment required is known; the fixed charges will consist of interest on this, making proper allowance for the shrinkage of debentures from face value; the sinking fund providing for serial retirement of bonds; the operating cost of generating, transmission, and distribution plant; the cost of maintenance, and the charge for depreciation of works and equipment, taxes and insurance. To offset the total of these is the receipt from current service. This is now a purely commercial problem and, if the old saying "that figures do not lie," could be taken for gospel truth, the conclusion would be infallibly correct; but *be sure that these figures are right or on the right side of error;* that is ever conservative.

The casual reader may have arrived here with an impression that the correct analysis of a hydro-electric project is somewhat of a rare feat, but be it far from my purpose to leave it at that; it is merely a case of the correct reading of the symptoms, which is much more practicable in a hydro-electric development than in determining the value of a mining proposition, of a railroad project, or of many other enterprises which are accepted with no lack of faith when "O. K.'d" by recognized authority. Why not also with the hydro-electric project? Merely because of its much more recent advent, in the sense of an important branch of enterprise, and because the authorities competent to pass upon it correctly are not so many nor so well-known as in the much older lines.

The succeeding article describes and illustrates some plants recently constructed representative of modern practice and a few undeveloped opportunities typical of many awaiting utilization. The series will be closed with an article treating of hydro-electric engineering presented from the commercial and industrial point of view.

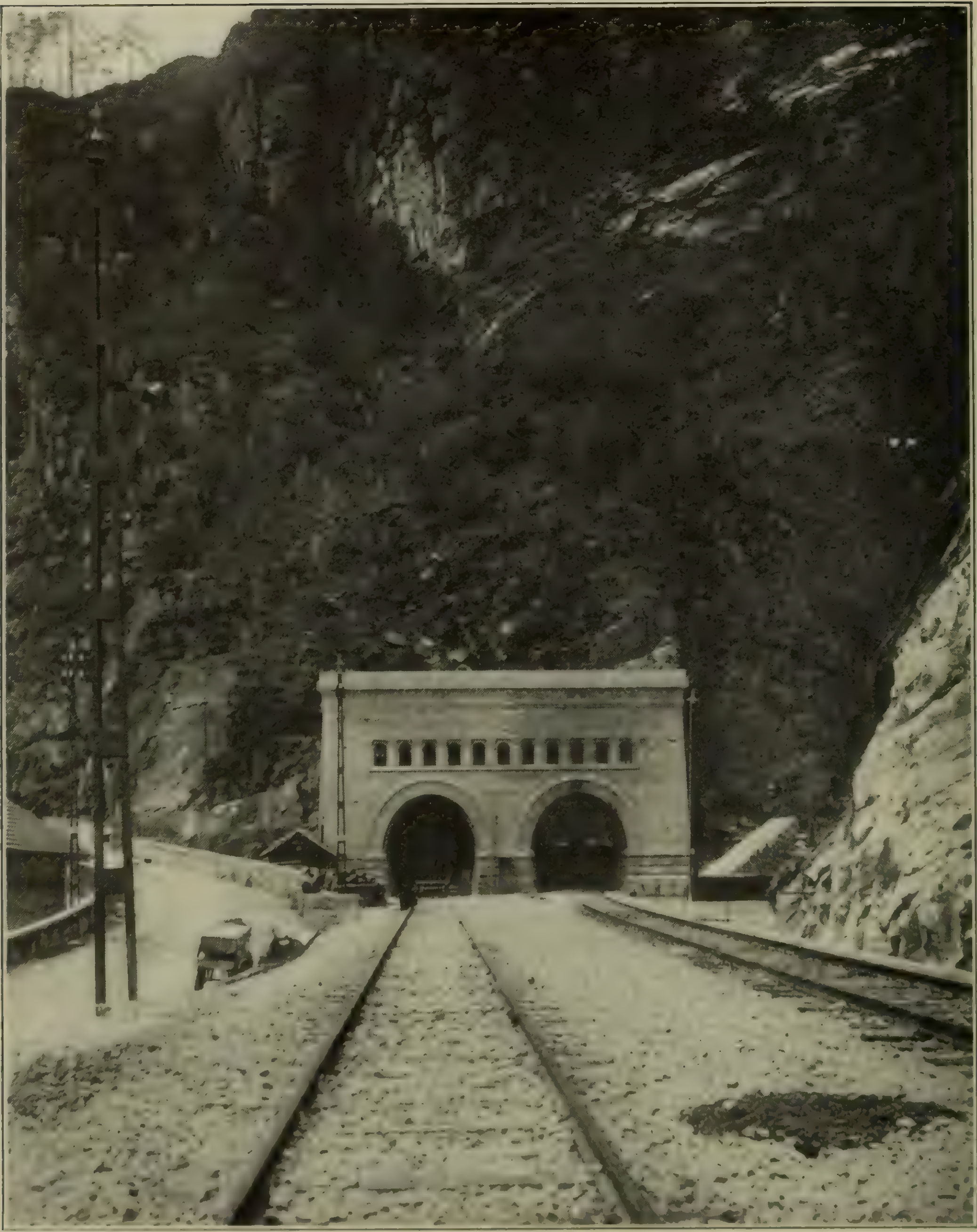
ELECTRIC TRACTION IN THE SIMPLON RAILWAY TUNNEL.

By J. B. van Brussel.

FOR several years past, even before the Swiss Federal Railways decided to adopt electric traction in the Simplon tunnel, most Continental manufacturers of electrical material had been giving this subject their most careful attention. The advantages of electric driving for tunnel haulage were evident; and one alone—the absence of smoke—is of such importance in lessening the great difficulty of satisfactorily ventilating a tunnel of great length, as to ensure the adoption of an electrical method of working, particularly as such great progress had been made recently in adapting electric traction to main-line railway work. It was felt that there was not the slightest risk in applying this system of working upon the most important main lines.

In Autumn 1905, Messrs. Brown Boveri & Co., the well-known Baden firm, made an offer to the Federal Railways to instal a system of electric traction in the Simplon, undertaking at the same time to have the work completed in time for the opening of the tunnel—that is to say, by a date which would correspond approximately to the opening of the International Exhibition of Milan. They offered to put the whole of this installation at the disposal of the Federal Railways so that a comparison could be made on a large scale between steam traction and electric traction. In the present case this comparison is of particular interest owing to the sections and general conditions of working of the Simplon line.

After having hesitated for about two months, as to the reply to be given, the Federal Railways authorities accepted the proposal, but on conditions which were somewhat onerous from the contractors' standpoint, as a clause in the contract stated that the authorities had power to abandon the system at the end of a year, and to call on the contractors to remove the equipment, if unsatisfactory results were obtained. Further, the contracting firm was required to have the electric equipment ready by June 1st, 1906. This acceptance took place at the end of the year 1905, so that a very short time only was



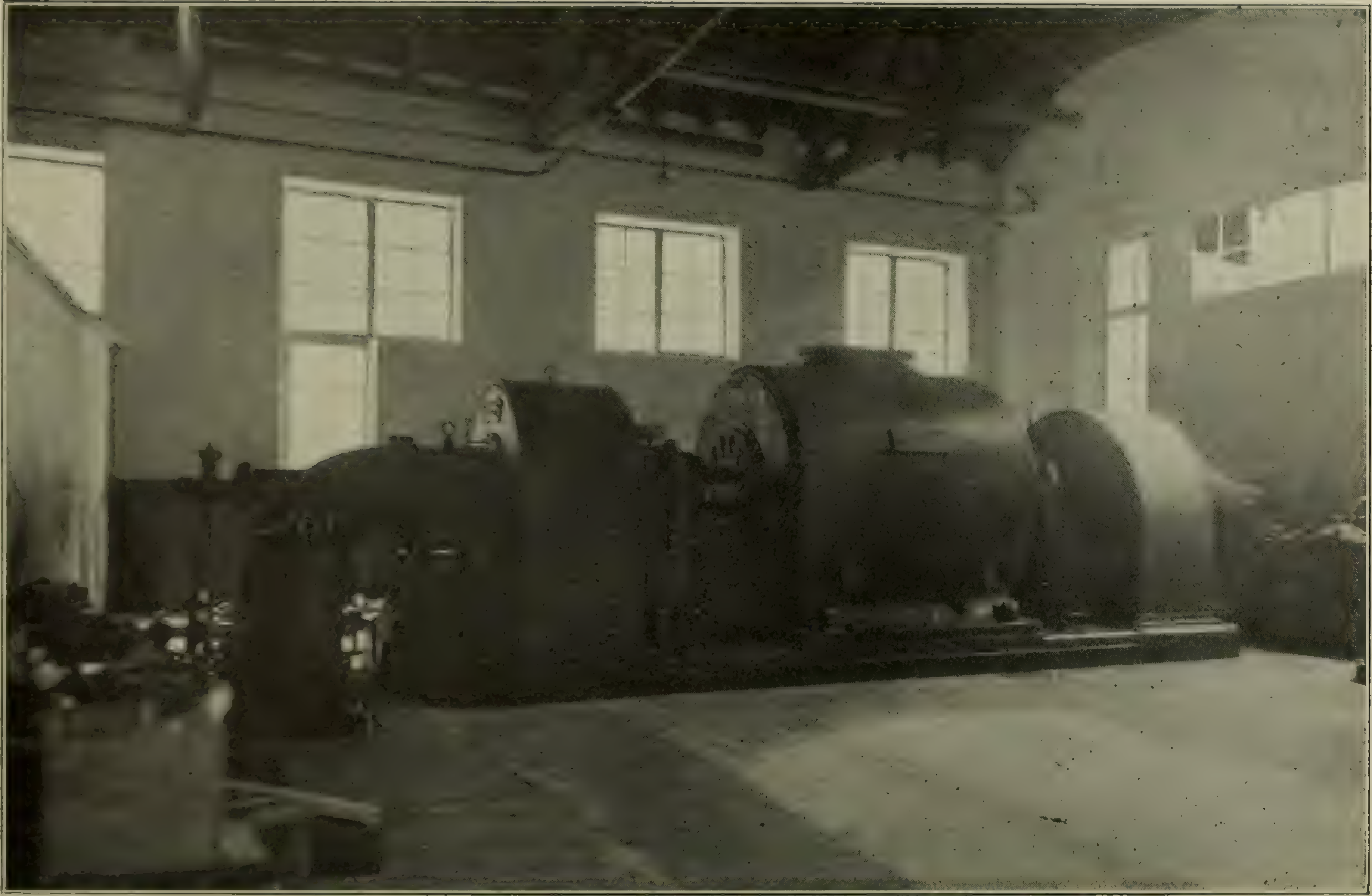
THE ISELLE ENTRANCE TO THE TUNNEL.

given for the fulfilment of the undertaking. For this reason the contractors selected that system with which they had had the greatest experience at that date, namely the three-phase system. As they had at that time two three-phase locomotives of 1,000 horse power in course of construction for the Adriatic Railways (Valtellina line), it was proposed (in order to gain time) to make use of these in the Simplon tunnel, and the matter was brought before the Italian Rail-

THE ENTRANCE TO THE TUNNEL AT BRIGUE.

way Company, who readily gave their consent to this, and moreover consented to put at the disposal of the contractors three additional locomotives of the Ganz type, to provide sufficient motive power for passenger and freight traffic.

Owing to the short time available for completion it was thought better to make use of existing sources of power supply wherever possible. The two water-power stations at Brigue and Iselle, which



WATER TURBINES AND ELECTRIC GENERATOR IN THE ISELLE POWER PLANT.

had supplied power for the many machines used in boring the tunnel, were somewhat modified and converted into temporary generating stations for the supply of the necessary current. Later on one large power house will be constructed, replacing these two stations, which are already somewhat out of date, and not as reliable in operation as could be desired.

The current is generated at a pressure of 3,300 volts and a periodicity of 16 cycles. This is perfectly suitable for direct supply to the motors without the use of intermediate transformers. In the central station at Brigue (Switzerland) there is one three-phase alternator rated at 1,200 horse power at 160 revolutions, but capable of supplying temporary overloads up to 1,500 horse power. It is driven from a main transmission shaft, which is itself driven by two Escher-Wyss turbines each of 600 horse power; the fall is 146 feet. The alternator is excited from a 95-horse-power dynamo which was part of the original plant. The Escher-Wyss turbine was not at that time fitted with an automatic regulator, and it was therefore necessary, in order to keep a constant speed, to use in the generator circuit a water resistance of such capacity that it could absorb, if necessary, the whole of the energy given out by the alternator. An automatic regulator is provided to adjust the capacity of the water resistance in accordance with the load on the line, so that the alternator is kept always fully loaded, and there is no risk of any serious variation of speed.

All the necessary measuring instruments and apparatus for controlling the circuits are mounted upon one switchboard, from which connections are carried to the overhead conductors and the rails, by means of overhead wires.

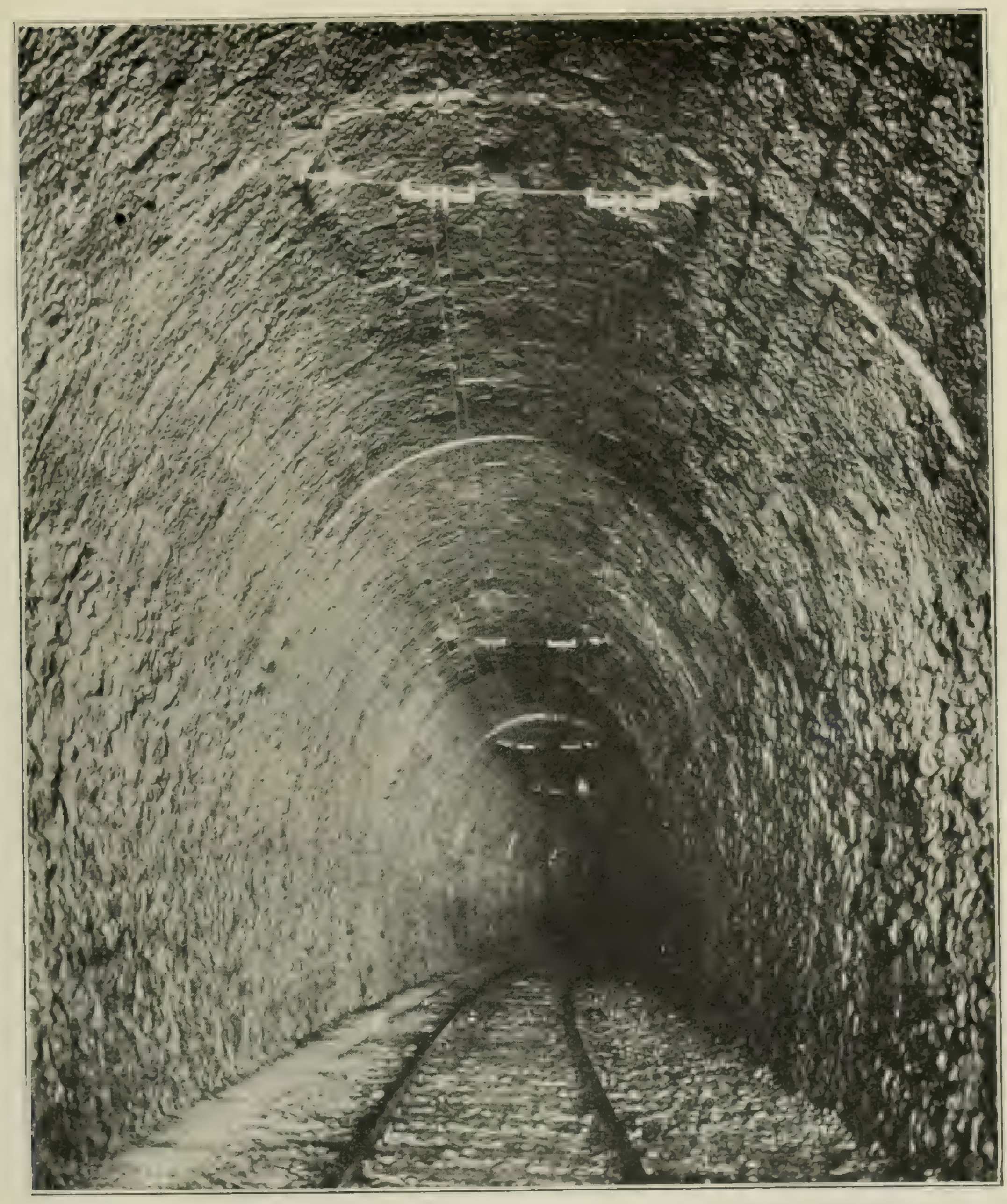
In the central station at Iselle (Italy), which is the old pumping station, there is one three-phase alternator rated at 1,500 horse power. It is direct-coupled to a double-ended turbine, each of the turbine units being capable of developing 750 horse power. The set runs at 960 revolutions with a fall of 460 feet and is fitted with a sensitive governor which keeps the speed nearly constant. This set can be overloaded up to 1,800 horse power and even more. The excitation current is taken from a continuous-current machine of 95 horse power and 125 volts, which was formerly used in the tunnelling operations. The switchgear is similar to that employed at Brigue.

As to the line, two of the phases are overhead conductors, the rails being the third conductor. The whole line is divided into five sections, as follows: 1, from the station at Brigue to the northern end of the tunnel; 2, northern half of the tunnel; 3, crossing in the middle of the tunnel; 4, southern half of the tunnel; 5, from the southern end of the tunnel to the Iselle station. Section switches are provided at Brigue, at Iselle, and at the station in the middle of the tunnel, and telephonic communication is provided for transmitting orders to the operating staff in charge of the switches.

SUSPENSION OF AERIAL CONDUCTORS ACROSS A NUMBER OF TRACKS.

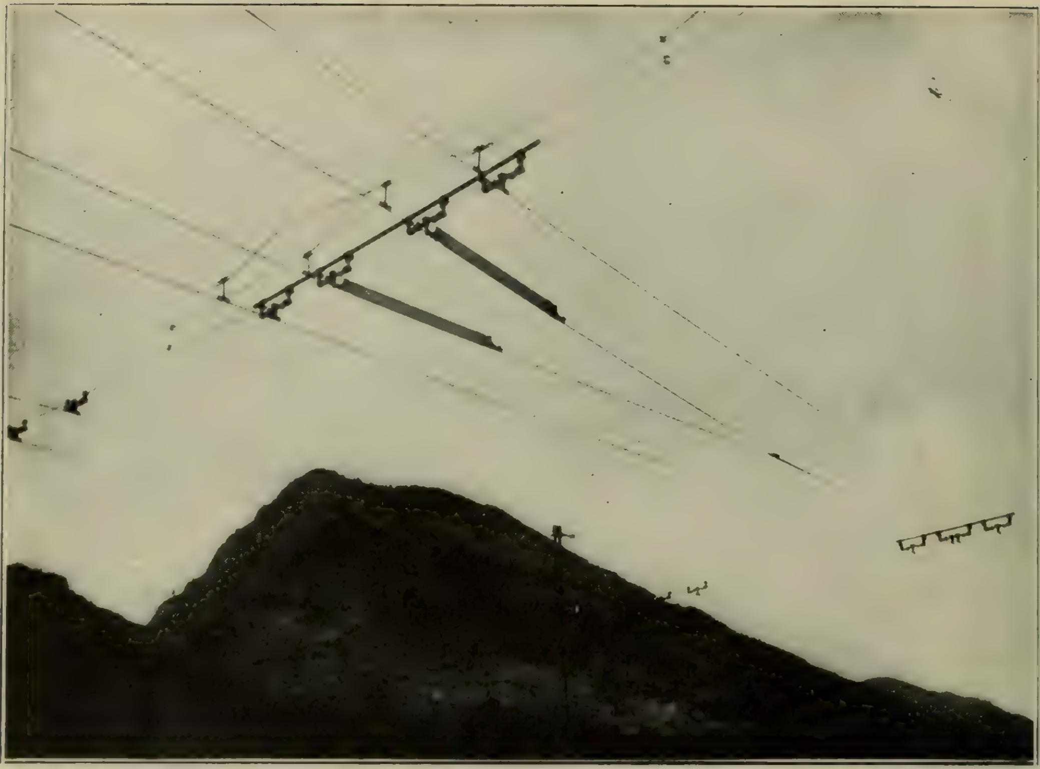
Outside the tunnel the overhead line is suspended on cross wires strained between steel poles which are placed on either side of the track. At Brigue there is a separate set of poles for each track, so that the whole construction is exceedingly solid, and further work can be carried out on one of the lines without affecting the other. At Iselle, on the contrary, this construction could not be employed, as the tracks are too near to one another to allow of poles between them. A very long cross wire is used, and the poles are placed on each side of the line and a catenary type of suspension is employed.

In the tunnel itself the conductors are carried on cross wires which go from one side to the other and are fixed by means of gun-metal bolts cemented directly into the face of the tunnel. These cross suspensions have been kept as simple as possible, and in order to give them maximum stiffness a single wire has been used, without any



INTERIOR OF TUNNEL, SHOWING MODE OF TROLLEY-WIRE SUSPENSION.

strain insulators, which would only have had the effect of weakening the suspensions. The suspension wires are fixed quite simply at each end to a porcelain insulator, arranged so that the wire may be drawn as tight as required. They are spaced about 83 feet apart on the straight portions of the line, and about 42 feet on the curves. It has not been found necessary to put them closer together than this, as the temperature in the tunnel is practically constant and the conductors can be strained very tightly, so that the sag is quite small even for a length of 80 feet or more.



SUSPENSION OF AN AERIAL CONDUCTOR.

In order to keep down the pressure drop in the tunnel, the total length of which is some 12½ miles, and as it was not considered advisable to use transformers there, conductors of a somewhat larger section have been used than were employed outside the tunnel, where the conductors are of .078 square-inch section per pole, being .315 inch diameter. It was decided to use two wires per pole, each of a similar section, in preference to using one wire of larger diameter, for the following reasons:—

1. The diameter of .315 inch is the largest in general use for overhead contact lines, and, further, there is a much better chance of getting thoroughly homogeneous and hard wires.

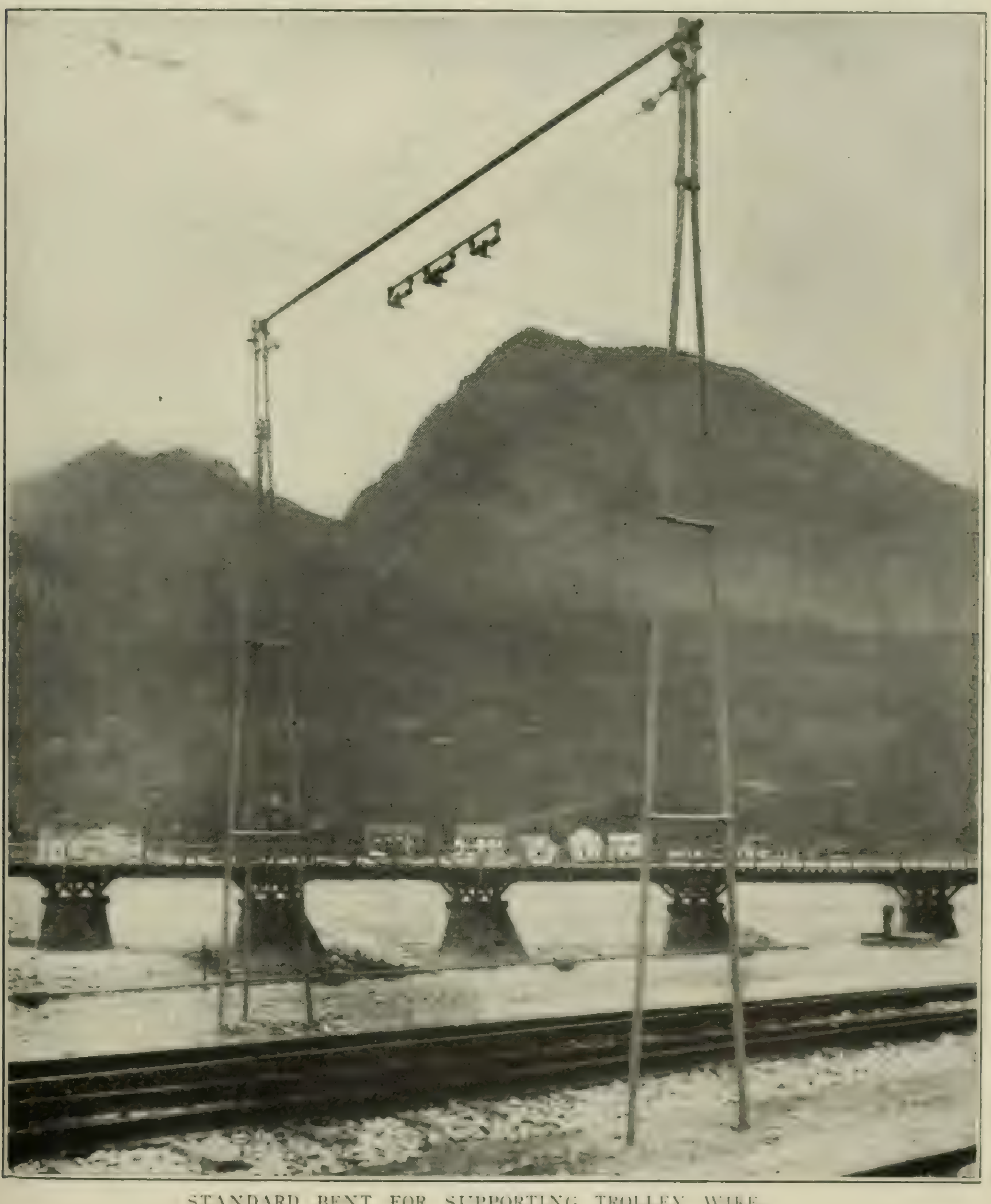
2. The smaller wires are far more easy to handle.

3. The fact of having two wires per pole ensures far better contact surface on the bow collectors.

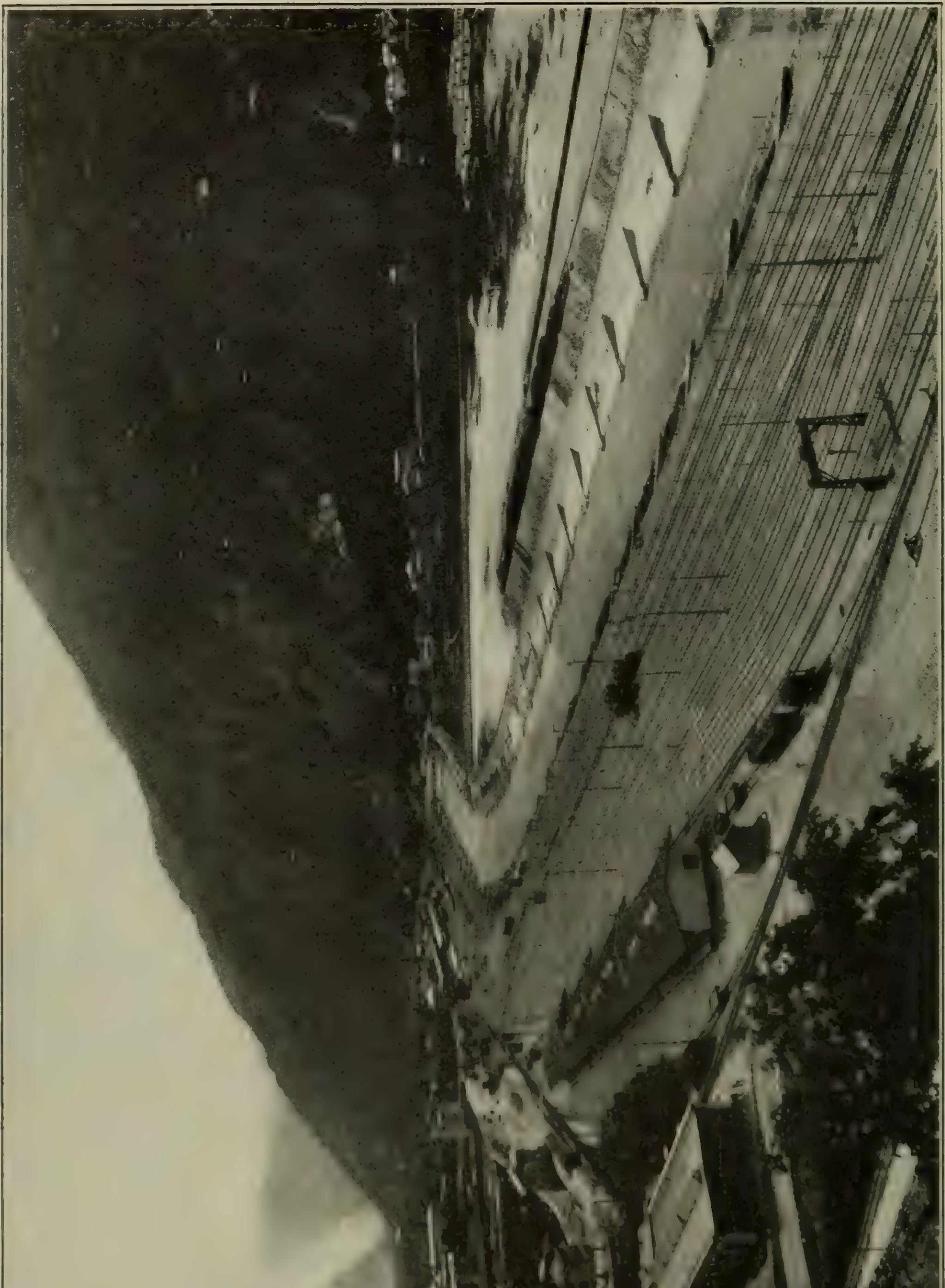
Over and above these advantages, the supply is not interrupted if one of the wires breaks, for current can still be supplied by the second conductor until pressure can be taken off the line and the damaged conductor replaced.

The conductors are carried on the cross wires by means of a special type of insulator. Double insulation is employed in ebonite and porcelain, so as to make certain of good insulation under all conditions, however unfavourable as regards temperature, moisture, etc. These insulators are constructed of a piece of ebonite in the form of a bolt, to which the conductor is suspended. This bolt is carried in a cross piece of gun metal fixed at its two ends in strong porcelain insulators by means of hemp and asbestos. These insulators are carried in gun-metal pieces by means of which the complete insulating block is suspended from the cross wire.

This system of insulating is thoroughly reliable, for even if one of



STANDARD BENT FOR SUPPORTING TROLLEY WIRE.



TRACKS AND OVERHEAD CONDUCTORS AT THE BRIGUE ENTRANCE TO THE TUNNEL.

the insulators is defective the other will be amply sufficient to prevent leakage and to allow of temporary working of the service until a suitable opportunity occurs for repair. These repairs can be carried out exceedingly quickly as all parts of the insulator can be separately replaced.

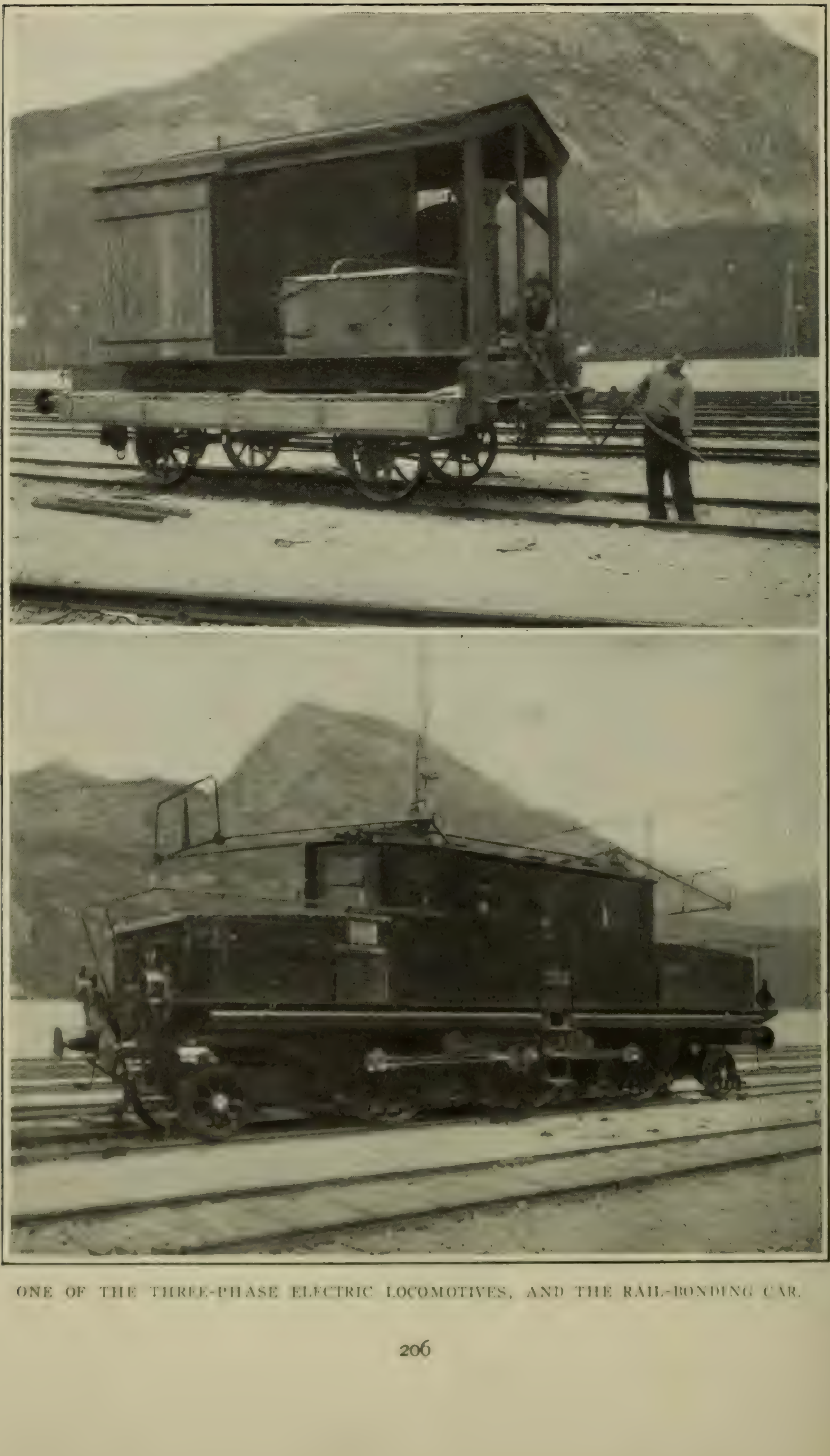
Periodic inspections are carried out on all the insulators, each of which is tested with a pressure of 18,000 volts. Each separate insulator, whether of ebonite or porcelain, is tested separately at 10,000 volts, so that the complete insulating block will stand a pressure of from 30,000 to 40,000 volts, which is far more than necessary for a working pressure of 3,300 volts, even under the most unfavourable atmospheric conditions.

In order to equalise the wear of the bows as much as possible, the overhead conductors are not kept parallel to the rails but are arranged in zigzag fashion on the cross wires.

As has been mentioned the rails themselves form the third conductor, and these are bonded in accordance with a system by which ordinary fishplates only are used to conduct the current from one rail to the next, and no special splices or copper connections are employed. In making this electrical joint the first thing to do is to clean thoroughly all the joints through which the current will pass. This is done by means of a sand blast specially constructed for the purpose. When these joints are once absolutely smooth, they are covered with a thin layer of patent paste, the object of which is to prevent absolutely any oxidation of the contact surfaces. The fishplates are then bolted up in the usual manner to the rails and a thoroughly good and lasting connection is made. The system is an exceptionally simple one, and has given satisfactory results where it has been used.

The locomotives securing the service are of the bogie type, with five axles, of which three are driven by the motors. The traction motors are placed between the three pairs of driving wheels, and both drive on the middle axle by means of a bar coupling them rigidly together. This axle in turn drives the other two by means of a coupling rod so that there are no gears. It appeared preferable not to key the motors onto the axles themselves, as the dismounting in this case would be much more difficult.

The locomotives are built on liberal lines. When starting at the higher speed with a passenger train weighing 300 tons, a draw-bar pull of 16,600 pounds is required in order to obtain the specified acceleration of 0.5 feet per second, and when starting at the lower speed with a goods train weighing 400 tons a draw-bar pull of 20,000



ONE OF THE THREE-PHASE ELECTRIC LOCOMOTIVES, AND THE RAIL-BONDING CAR.

pounds is required to obtain the specified acceleration of 0.36 feet per second.

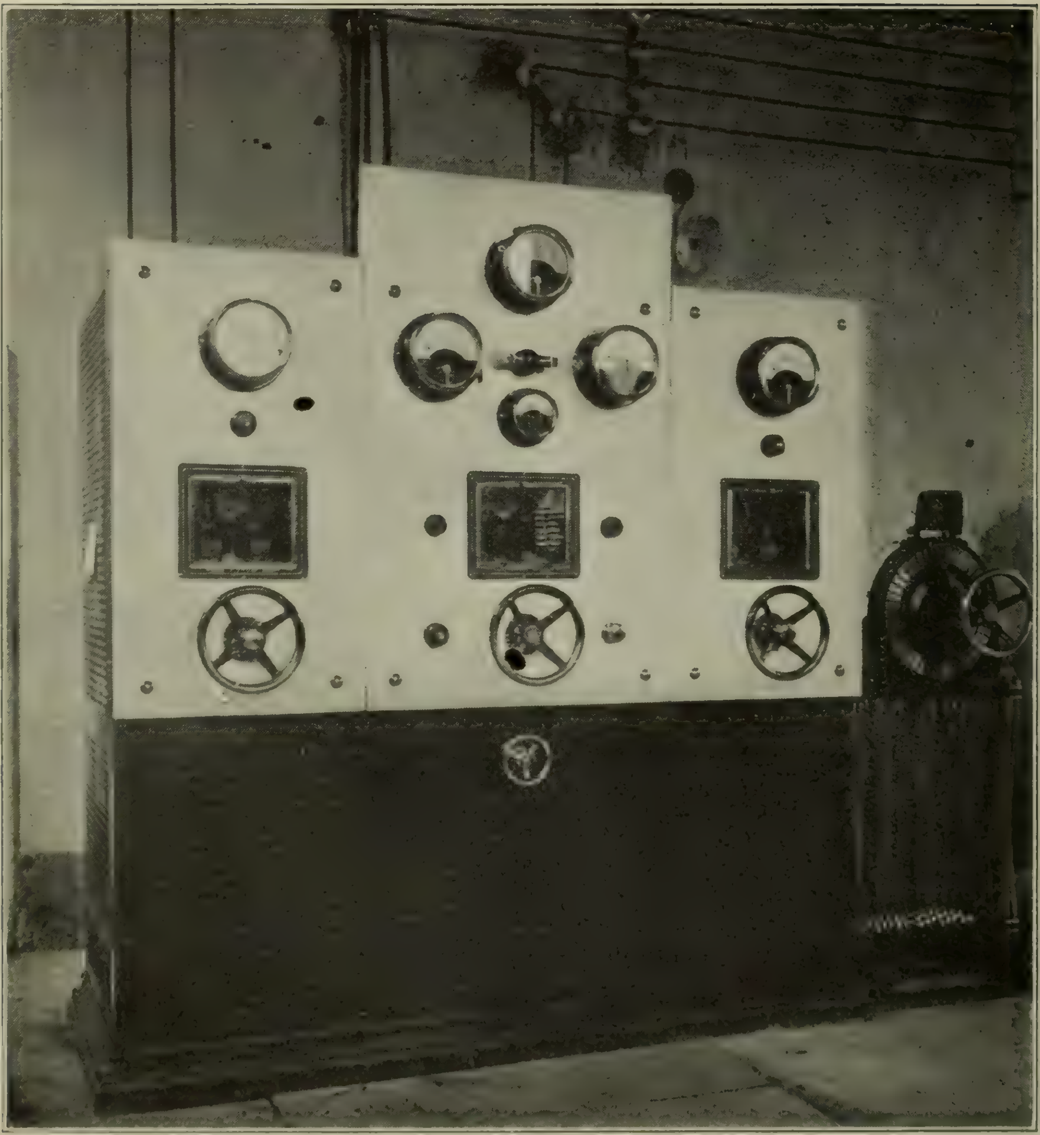
The following are the leading dimensions of these locomotives:

Length between buffers, 40 ft. 6 in.
Total length between axles, 31 ft. 10 in.
Distance between driving axles, 16 ft. 1 in
Distance between bogies, 23 ft.
Diameter of driving wheels, 5 ft. 4½ in.
Diameter of smaller wheels, 2 ft. 9½ in.
Weight on the driving wheels, 42 tons.
Weight of the mechanical portion of the equipment, 34 tons.
Weight of the electrical portion, 28 tons.
Total weight, 62 tons.
Normal output of the two motors together, 900 h. p.
Maximum output of the two motors together, 2,300 h. p.
Weight of the motor complete, 10¾ tons.
Normal speeds, 42 miles and 21 miles per hour.
Draw bar pull at 42 miles per hour, 7,700 lb. normal, and 20,000 lb. maximum.
Draw bar at 21 miles per hour, 13,500 lb. normal, and 31,000 lb. maximum.

Air pressure is used for raising and lowering the bows, and for operating the high-tension switches. This air supply is provided by a couple of small electrically-driven compressors, the power for which is obtained from the main trolley-line, through small oil-cooled static transformers rated at 7 kilowatts, and giving current at 110 volts. One of the air-compressors in normal working provides the air necessary for the Westinghouse brake, and the other that for the whistle, the pneumatic sanding appliances, and for operating the high-tension switches. The pumps deliver air into reservoirs placed below the foot-plate, and means are provided by which the current is cut off from the compressors automatically, when the reservoir pressure exceeds 7½ atmospheres, and also automatically started up again, when the pressure falls.

The regular working of the electric trains through the tunnel began, as fixed, on June 1st, 1906. Unexpected difficulties were then quick to declare themselves, the most serious being a failure of the insulation of the new engines, due to the extreme moisture and the heat of the air of the tunnel, which is regularly of about 93 degrees F. These, however, were promptly overcome. On renewing the insulation of the locomotives the air-ducts provided were closed, a procedure which was possible because the trip through the tunnel lasts only 20 to 30 minutes, and the locomotives can easily carry their full load for this length of time without overheating even when the ventilating ducts are stopped as stated.

Some interesting observations on the increase of train resistance on passing through the tunnel have been made. Measurements



SWITCHBOARD IN THE BRIGUE POWER STATION.

proved that about 400 horse power more is required to haul a train at 43½ miles per hour through the tunnel than would suffice for it in the open. It was further found that on the 7 per 1,000 gradient from the summit to the Iselle portal the motor would not run down by gravity if alone, but would with a train behind it. The speed, however, never exceeds 33 miles per hour, under these conditions, so that the extra resistance of the tunnel as compared with open track is apparently about 15 pounds per ton, and this although the ventilation is in the direction of the motion. The resistance is slightly greater to motion in the reverse direction, but not very materially so.

PRESENT PRACTICE IN THE USE OF SUPERHEATED STEAM.

By Reginald Pelham Bolton.

III. LOCOMOTIVE AND MARINE APPLICATIONS AND SUPERHEATER DESIGN.

Mr. Bolton's series began in March last with a review of the troubles experienced by the early users of superheat, the most important recent tests and experiments, American and Continental, and the general relations of superheating to economy in the steam cylinder. His second paper took up the variance between American and European practice in the use of high superheat, the use of superheating in steam-heating practice, and the design and construction of piping systems, etc., where high degrees of heat are used. The article now presented concludes the study, and to it is appended a bibliography of the contributions to the subject in Society transactions and the technical press during the past fifteen years, as compiled from the Engineering Index.—THE EDITORS.

IN locomotive practice, the conditions on the face appear to be largely favorable to an economic use of superheat. The high temperature of waste gases, the peculiarly adverse cooling and condensing cylinder conditions, and the close physical relation of gas uptake and cylinders, all lend themselves to adaptations which appear to present no very considerable difficulty comparable with the results attainable.

The practical trials instituted by the Prussian Railway authorities in 1904, and carried out with a set of similar machines, operated over a given section of road, with similar loads, and at 185-pounds working pressure, showed a progressive gain, as follows:

With 50° F. superheat, Water saved, 2.5 per cent.; Coal saved, 2 per cent.
With 104° F. superheat, Water saved, 10 per cent.; Coal saved, 7 per cent.
With 158° F. superheat, Water saved, 16 per cent.; Coal saved, 12 per cent.

The subject is one in which the past record of locomotive engineering in the United States demands the active present interest of that branch of the profession, now so insistently called upon to compete with a method of traction using power distributed from central points. This latter system, cumbered as it is by superior charges for labor, for installation and maintenance, has but one source of advantage over the use of the independent steam locomotive, namely, the superior economy of net power production by enlarged apparatus; and had the methods of locomotive design kept pace with the competitive development of power-station practice, it is probable that less would be heard of long-distance electrical haulage.

Locomotive engineering seems to have been to a great extent a stationary practice since the partial adoption of compound cylinder work, the real economy of which is evidently bound up with the adaptation of superheat, toward which little or no effort has been made.

MARINE PRACTICE.

In marine practice, it is regrettable to have to admit that very little advance has been made by American engineers in the past decade. Had the initiative in the matter of turbine development come from the United States, undoubtedly the cognate subject of superheat must have followed and kept pace with it. But patent restrictions surrounding the modernized developments of that very ancient appliance have retarded, until quite recently, the introduction of the turbine in American marine work, and American engineers must feel humbly gratified, therefore, that there are at the present moment some substantial vessels building in American yards in which both turbines and superheaters are adopted.

The huge experiment of the Mauretania, which will soon interest us, and, as will be fully expected, reward those whose splendid faith has brought about her engine construction, will undoubtedly lend a great impetus in this direction to other marine owners and engineers.

One of the most definite, extensive and continued demonstrations of the value of the application of superheated steam to marine work is shown by the record of the steamers of the "Inch" line,—the steamships Inchdune, Inchmarlo, Inchkeith, Incharan and Inchmore, a description of which may illustrate the work capable of accomplishment in this direction.

These are fine freight vessels of 6,000 tons, fitted with quadruple expansion, five-crank engines, one high-pressure, two intermediate, and two low-pressure cylinders; the air, bilge, and feed pumps are driven off the main engines. The two steamers first-named were placed in commission in 1900, and were succeeded by the later vessels.

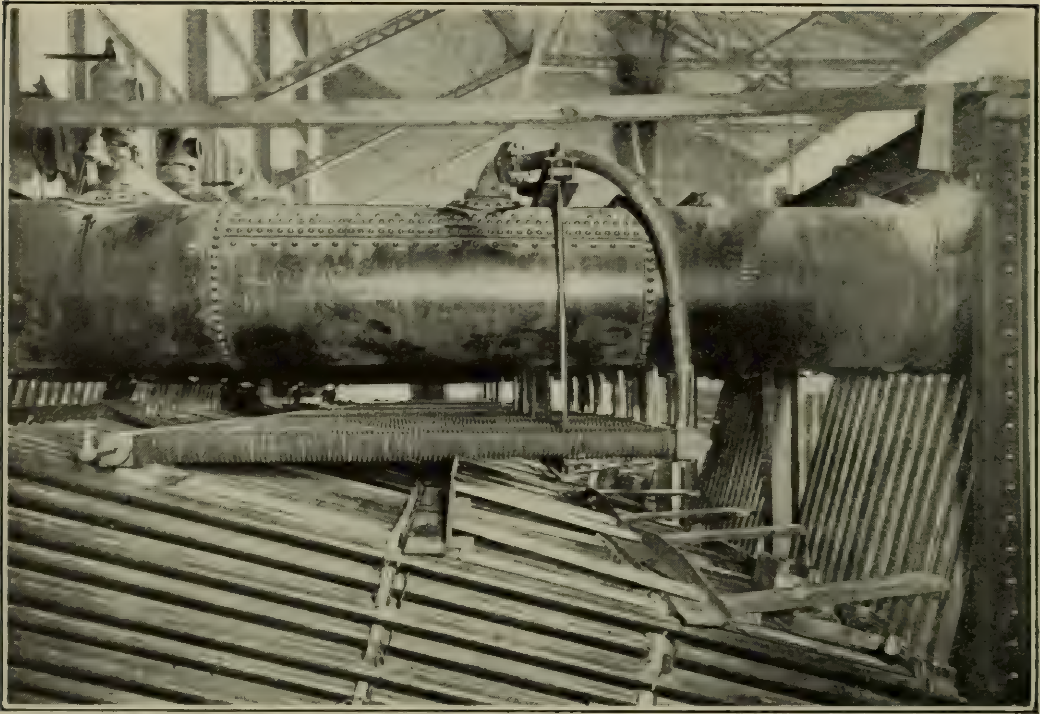
The working pressure is 267 pounds per square inch, and a superheater, built by the Central Marine Engineering Works, of West Hartlepool, consisting of 168 waved tubes in three sections, is set in the uptakes, just above the upper row of tubes of the two Scotch boilers, each of which is 13 feet in diameter by 10 feet 6 inches long. The arrangement provides for the progressive heating of the steam and progressive cooling of the gases. The steam is superheated from 412 degrees, (the temperature corresponding to a condition of dry saturation at 267 pounds per square inch), to 469.5 degrees, or an ad-heat of 57½ degrees F. The temperature is maintained in the second receiver, and at the high-pressure steam chest averaged 447 degrees. The work is accomplished by the waste gases, which in addition heat the air for the furnace supply about 250 degrees, or from an outside temperature of 54 degrees to 299 degrees F., the draft being handled on the Ellis and Eaves system.

On a trial, the waste gases below the superheater were at 620 degrees, reduced by the superheater to 543 degrees, and by the air-heating tubes to 404 degrees, the temperature of chimney discharge, showing the very good result of over 33 per cent of the waste heat turned into useful work.

Feed arrangements were good, increasing the hot-well temperature of 96.5 degrees F. to 310 degrees at the boiler feed. With these generally obtaining conditions, on a sea trial of the Inchdune and Inchmona, between West Hartlepool and Dover, the coal consumption was reduced to the extremely low rate of 0.97 pound per indicated horse-power. This excellent result has been practically maintained, for on a very recent visit of the Inchkeith to the port of New York, it was authoritatively ascertained from the owners' representatives that her entire coal consumption over 12 months has not exceeded 1.1 pound of coal per indicated horse power, including, of course, all auxiliaries. This fuel has varied from the best Welsh coal, on out-bound trips, to the poor Bombay slack, on her return runs from Asia.

The fact that these vessels have proven so satisfactory, during five years' service, that successive additions have been made to the fleet of vessels of the same type, and with the same feature of the use of superheat in the steam supply, not only demonstrates the excellence of their construction and design, but also sufficiently defines the economic advantage of superheat and the practicability of its permanent maintenance. Mr. William Bloor, M. E., who was the engineer in charge of the trials, and to whom I am indebted for the details herein given, states further that the diagrams showed an area of 89.7 per cent of the area between highest and lowest pressures, and that comparative diagrams, with saturated steam, showed superiority in area of the superheated vapors as high as 15 per cent.

The economy of operation of these boats is remarkable. At a speed of 9½ knots, a consumption of 1.1 pound works out to only 17 tons per diem, and at an average price of $4.00 per ton, the cost of fuel would be 22 cents per mile, or at 6,170 tons dead weight, one ton is carried 280 miles for a cent.



FOSTER SUPERHEATER, SET IN BABCOCK & WILCOX BOILER, NAVY YARD, WASHINGTON, D. C.

One of a battery of five; there are four such batteries, or twenty units altogether. Working pressure, 200 lb.; superheat, 120 degrees. Power Specialty Co., N. Y.

SUPERHEATERS.

In superheater construction much has been accomplished, and very practical forms have been developed by American engineers. The larger boiler manufacturers have devoted time and expense to the preparation of apparatus capable of desirable application to their particular types of steam generator, and a choice of excellent forms of superheaters, combined with boilers, is now available.

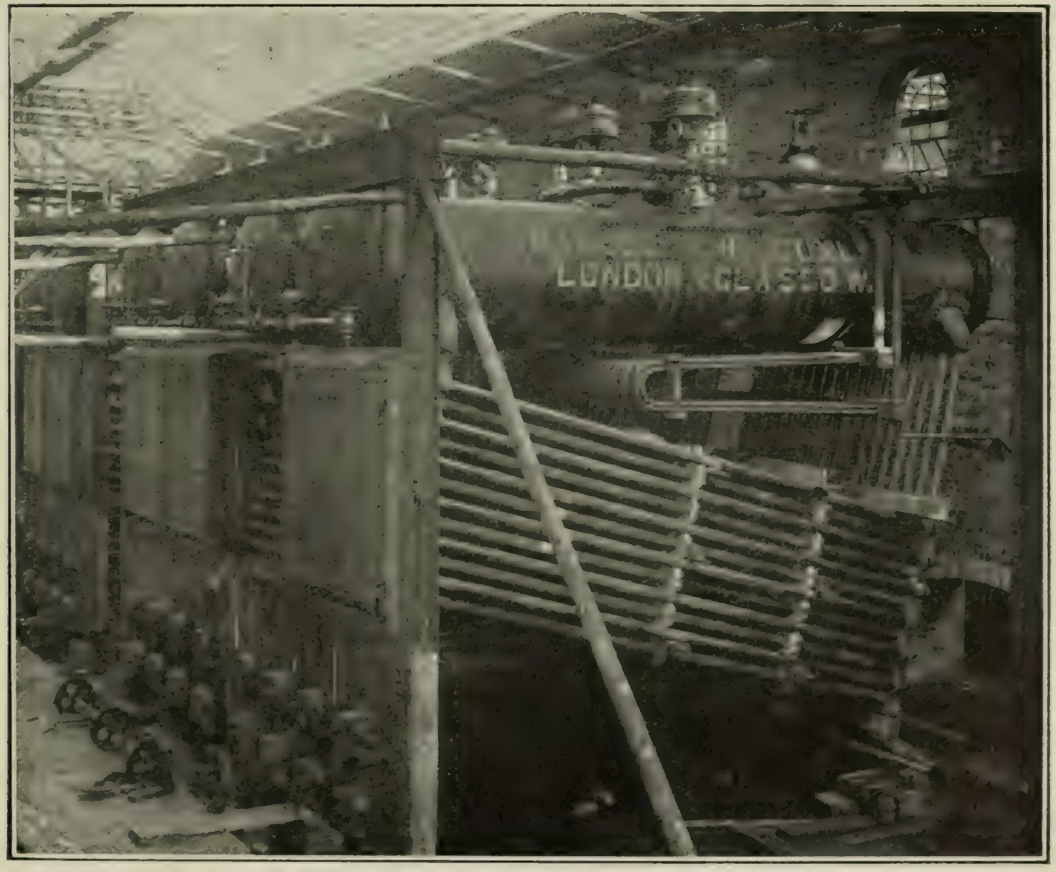
The pioneer work of Mr. E. H. Foster, M. E., in this matter, must not pass unrecognized, as there can be no doubt that to his persistent advocacy of the practicability of the system of combined (as well as of separate) superheating apparatus, much of the present extent of such installations is due. His paper on this subject, read in 1901 before the American Society of Mechanical Engineers at Milwaukee, formed a striking re-statement of the case for superheat, which drew wider attention to the subject, and made the second half of the decade which we have been considering a more active period in this direction than the prior portion.

The many forms of superheat generators, chiefly German, evolved, by a tedious process of elimination, the general types of superheaters of today, which may be divided into two main classifications, viz:

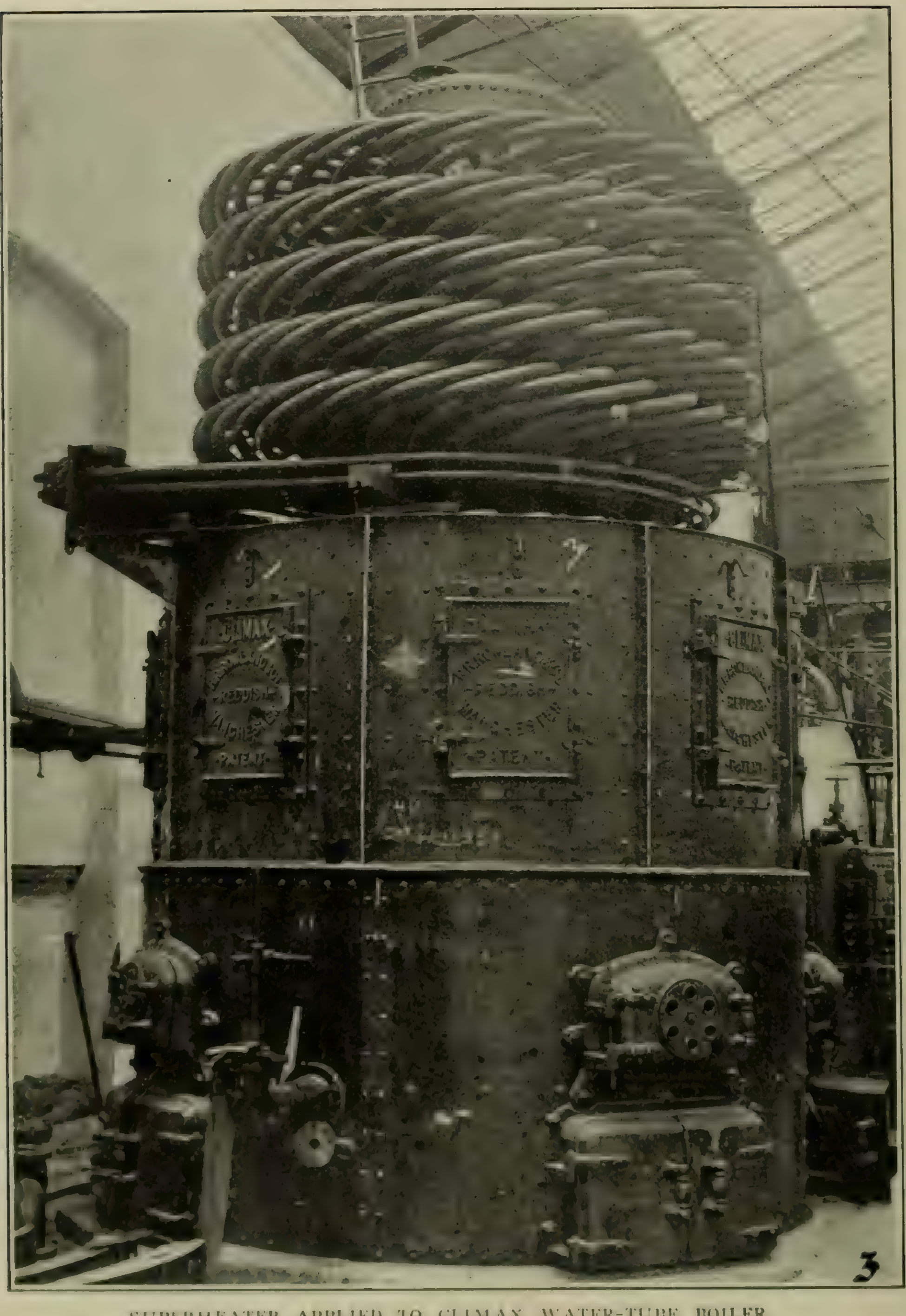
those contained with and forming part of the boiler and flue combination, and those separately fired, with the further detail difference of wrought or cast materials in their construction.

Into the merits of the two forms of super-heater—the independent, and that combined with the flue system of the boiler—I cannot here enter, save to say that undoubtedly each has its proper place, and each should always receive due consideration in any well-developed design of steam plant. A number of German and other devices and methods are illustrated in the paper by George Hutchinson, Vol. XXII., Transactions American Society Mechanical Engineers, which may be studied to advantage.

It has been at this point of the advance of the practical provisions for superheat that American engineering took up with any degree of interest the construction and adaptation of the appliances, in which line excellent results have been so far accomplished with moderate degrees of added heat. While some data are already available as to the desirable and effective relation between gas and steam tempera-



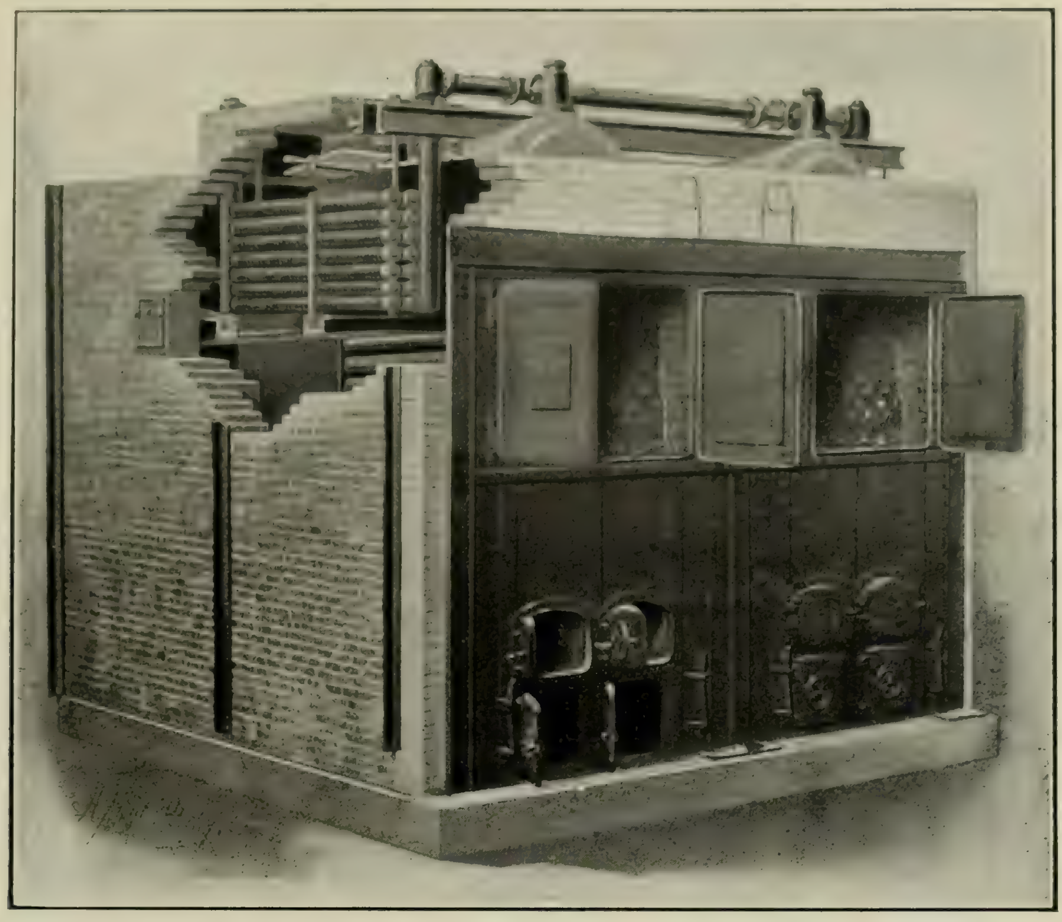
BABCOCK & WILCOX SUPERHEATERS AND BOILERS, SOUTH DOCK, CARDIFF, WALES.
Five boilers of 4,780 sq. ft. heating surface each, fitted with superheaters each having 452 sq. ft. heating surface, capable of imparting 100 degrees superheat to the steam.
Babcock & Wilcox, Ltd., Renfrew.



SUPERHEATER APPLIED TO CLIMAX WATER-TUBE BOILER.
B. R. Rowland & Co., Ltd., Reddish, Manchester.

tures, further observation and study will undoubtedly be repaid and a wide field for further developments exists.

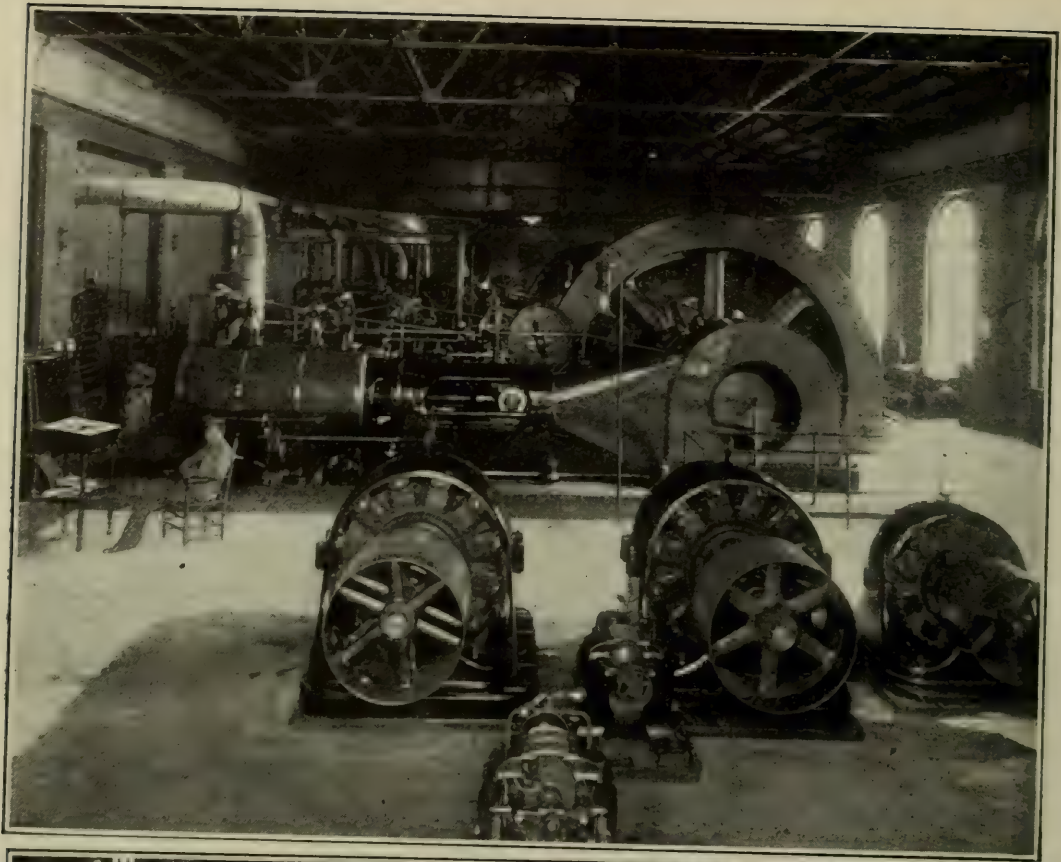
In this direction, the path marked out for the future appears to lie in a better relation between the superheating apparatus and the gases of the furnace—not a relation which shall provide a mere fixed and secondary position with regard to the heating element, with a



FOSTER SUPERHEATER IN WATER-TUBULAR BOILER OF HEINE OR FRANKLIN TYPE. One of ten units now being installed for Northern Colorado Power Co. under the engineering of Westinghouse, Church, Kerr & Co. The superheater receives heat through a side flue in the boiler setting, the gases making two passes and the heat being controlled by an adjustable damper. Pressure, 200 lb.; superheat, 100 degrees. Power Specialty Co., N. Y.

resultant degree of uncertainty and often undesirable fluctuation in effect; but an arrangement which shall provide some more definite and controllable share in the disposition of heat. The value of the superheater appears to justify a position in a boiler setting in which it shall not be expected to operate merely by the capricious eddies and flows of half-cooled and intermittent gases; it should be so placed that it shall receive its due proportion of heat flow, and that it shall not be exposed to superfluous heat when the demand for its work has slackened, nor be restricted so as to be unable to respond to an increased demand.

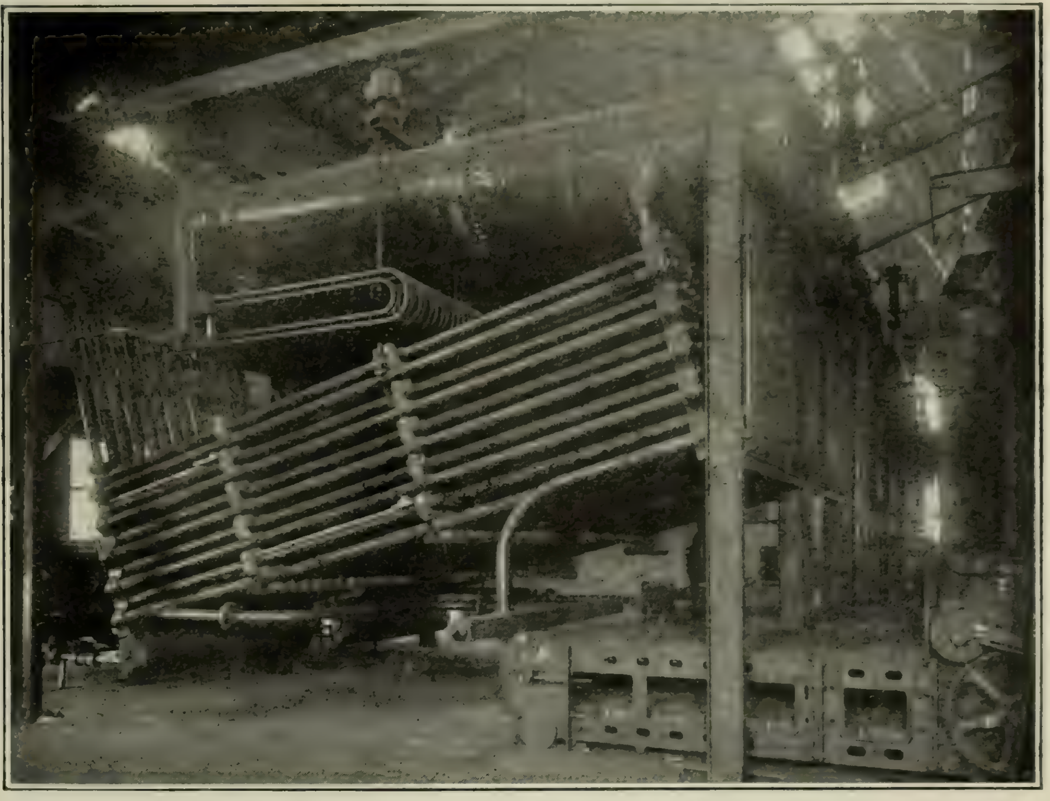
The extent to which any boiler and furnace combination can afford to divert heat to a superheater is ascertainable. Manifestly, the gas temperature must be considerably in excess of the final steam temperature, and if the waste gases go off at an economical temperature, as for example one lower than 500 degrees F., there is little



RICE & SARGENT ENGINES FOR HIGH SUPERHEAT AND SEPARATELY FIRED SCHMIDT SUPERHEATER, EDISON ELECTRIC ILLUMINATING COMPANY'S STATION, LANCASTER, PA.

Three engine units, each of 1,500 horse power; size 26 and 50 by 48; poppet valves on high-pressure cylinders. Providence Engineering Works, Providence, R. I.

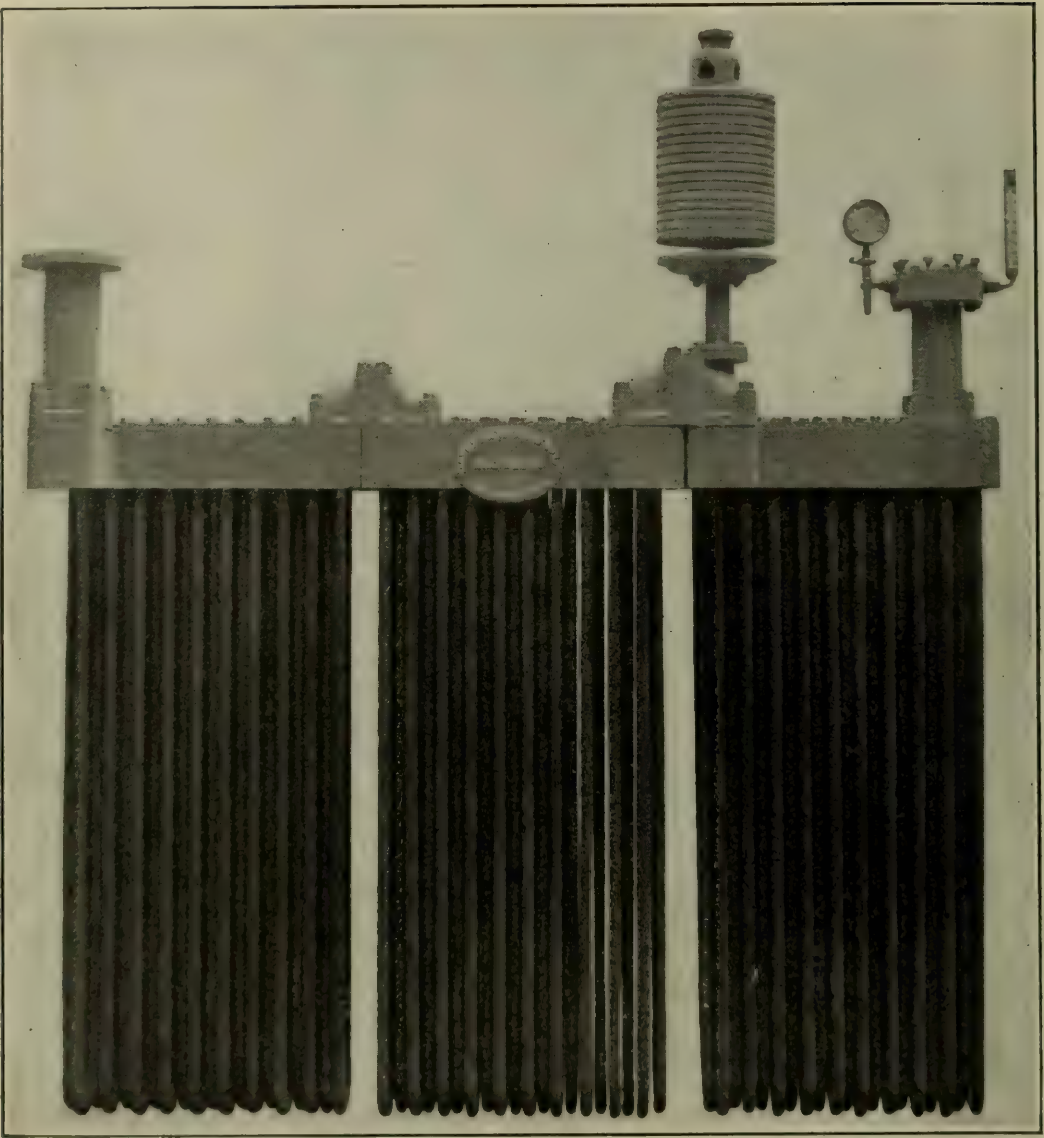
superheating to be accomplished with steam at 150-pounds gauge pressure, the normal temperature of which is 365.7 degrees F.; an addition of 100 degrees superheat to this would bring it practically to the mean temperature of the escaping gas. If such a temperature be required, the superheater must be placed where the temperature of the gases is considerably higher, and where, after the abstraction of the necessary heat for the superheat, they will still be at a temperature high enough to enable them to effect the necessary chimney or draft work.



BABCOCK & WILCOX BOILERS AND SUPERHEATERS, KIRKLAND AVE. PUMPING STATION, CLEVELAND WATER WORKS, CLEVELAND, OHIO.
Each boiler is 14 sections wide, 10 tubes high, 18 ft. tubes, with two 36-in. drums. Working pressure 200 lb.; 300 horse power. Superheat 150 degrees. Chain-grate stokers.
Babcock & Wilcox Co., N. Y.

This has led to the now rather usual practice of placing the superheater in the upper part of the second "pass" of gases in the horizontal water-tube type of boiler so widely in use. In such a position, good work can be obtained at moderate degrees of superheating, generally below 150 degrees F., and more commonly below 100 degrees. The relation between heating surface and superheater surface under such conditions varies very greatly with the location and the gas path.

In a test of water-tube boilers, bearing a relation of superheating

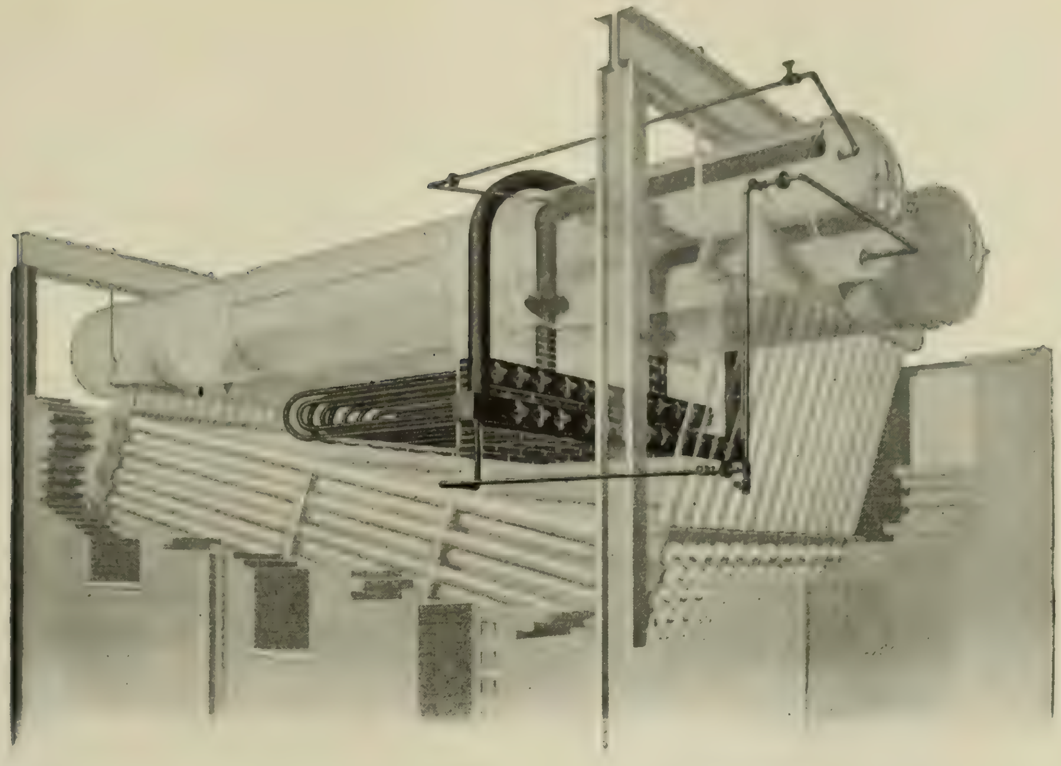


SUPERHEATERS BY DAVEY, PAXMAN & CO., COLCHESTER. THE BOXES ARE OF MILD STEEL.

surface to heating surface and grate area of 34 per cent and 1 to 16 respectively, and burning per square foot of grate 12.97 pounds of dry coal of 13,488 British thermal units heating value per pound, steam at 151-pounds pressure was super-heated 21 degrees F.

In a test of a combination of a superheater with an Edgemoor water-tube boiler, coal of 14,060 heat units per pound was burned at the rate of 25.5 pounds per square ft. of grate area per hour; the gases furnished passed into a Schmidt super-heater, the details being:—

Grate area, 66.8 sq. ft., or 5¼ per cent. of the superheating surface.
Water-heating surface, 3,332 sq. ft.
Superheating surface, 350 sq. ft., or 10½ per cent. of heating surface.
Steam pressure, 147.4 lb.
Flue gases, 582° F.



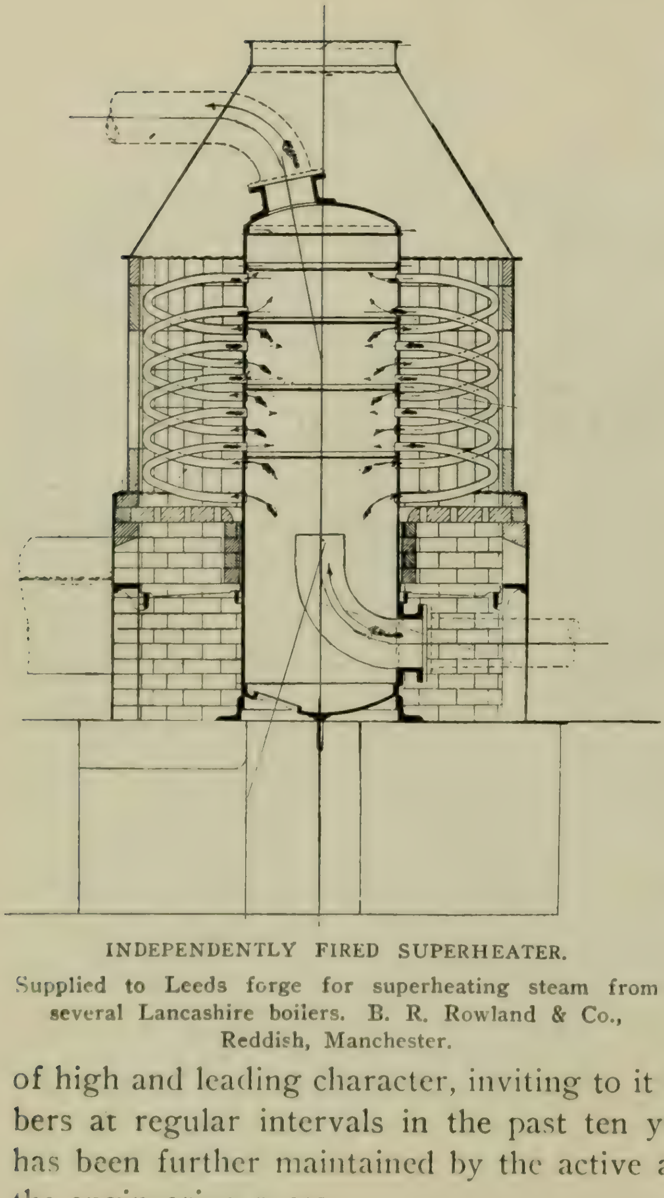
"PHANTOM" VIEW OF BABCOCK & WILCOX SUPERHEATER, SHOWING ITS RELATIONS TO BOILER AND SETTING.

The steam entered the superheater at 365.6 degrees F., and left it at 809.1 degrees, an addition of 443 degrees, the combined evaporation of both boiler and heater being 7.09 pounds, equivalent to 10.07 pounds from and at 212 degrees, affording a combined efficiency of 69.2 per cent.

REFERENCES.

The literature of this important and absorbing subject is of a peculiarly meagre and scattered character, not readily accessible to those to whom it is most desirable that it should appeal. Much of it consists of records of tests in which added heat has been applied to pre-existent combinations, affording, as has been said, gratifying but misdirecting results. But even such partial indications are of value, since so many ineffective plants are in existence, the owners and engineers of which may derive a practical interest in the subject by ascertaining what others have accomplished in some direction nearly parallel to their own conditions.

I feel, therefore, that the widespread circulation, by means of this Magazine, of even a partial bibliography of the subject will be justified, and a study of any, or all, of these can be recommended to all



INDEPENDENTLY FIRED SUPERHEATER.

Supplied to Leeds forge for superheating steam from several Lancashire boilers. B. R. Rowland & Co., Reddish, Manchester.

classes of power engineers. The bibliography below is compiled in collaboration with the Editors of THE ENGINEERING MAGAZINE, and is drawn chiefly from the volumes of the Engineering Index. A very broad general division is made, according to the tenor or character of the articles indexed, and below that the arrangement is chronological. The period covered is about fifteen years.

It is gratifying to be able to state that the presentation of the subject before the esteemed American Society of Mechanical Engineers by Thurston, Carpenter, Foster and Hutchinson has been of high and leading character, inviting to it the attention of the members at regular intervals in the past ten years—an attention which has been further maintained by the active and intelligent interest of the engineering press.

A BIBLIOGRAPHY OF ARTICLES ON SUPERHEATED STEAM.

GENERAL.

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A THEORY OF STORES OPERATION FOR MACHINE SHOPS.

By H. L. Whittemore

While correctly styled a "theory," Mr. Whittemore's article is truly an expression of practice reduced to its essential principles. The ideas as here given were worked out in the management of the stock room of an electrical manufacturing company of international range and reputation, and proved thoroughly useful.

Stores keeping is admittedly one of the departments of works management which has not yet been generally brought to a fully satisfactory solution. We are glad to offer, in Mr. Whittemore's discussion, a really significant contribution to the subject. And it will serve to offset, for many of our readers, the disappointment arising from the regrettable but necessary interruption, for this one issue, of Mr. Carpenter's series on "Profit-Making Management."—THE EDITORS.

THE importance of a separate department for the care and storage of material, in a modern manufacturing plant, has caused great attention to be paid to the subject. Much of the information which has become available, however, deals more with the arrangements for storing the material to allow proper access, and to the routine, including the printed forms used, than it does with the fundamental considerations governing the kind and quantities of material to be stocked. Of course, the final solution of these problems depends upon the particular case under consideration, but there should be some guide for such work which would prevent serious errors.

In most cases, the quantities are fixed by rough estimation and corrected, if at all, after experience has proven them unsuitable. Different persons frequently disagree as to the necessary quantity, and even estimates made by the same person, under identical conditions, have varied widely, tending to prove that the estimate was based very largely upon "guesswork."

Such confusion in determining the diameter of a shaft in designing a machine would hardly be possible. While neither case is capable of an exact solution, it has been found that an investigation into the theoretical considerations has been an assistance in design; possibly it would also prove profitable in the case of "stores." Even if mathematics can not be used to advantage, there are certain relations between the quantities fixed for any one article, which, if kept in mind, should put the work on a more rational basis.

If manufacturing be defined as the raising of material in value, from the condition found in nature, by the expenditure of human energy or work, a stores, as a factor in that operation, is the systematic care of such material when not actually undergoing the manufacturing process. By its very nature, it plays a passive rather than an active part, being in fact a *reservoir* and subject to the law governing them, of being able to discharge only what it has first received. The capacity is not as definitely limited as in some examples but is increased beyond a certain point only by the sacrifice of efficiency of operation. The sole function of a stores is to deliver the material, at some future time, with the lowest possible expense for storage.

The whole problem is one similar to that of transportation—the difference being that while transportation effects a transfer of material from one point to another, through an intervening *space,* time being only an economical consideration, a stores transfers material from one point to another, later point in *time,* any movement through space being for economical reasons only. The necessary condition, in either case, is that the material should remain unchanged during the transfer. The seasoning of lumber, ageing of wine, etc., by long storage, should properly be considered manufacturing processes in which time enters largely, but to be reduced if possible, as by the use of a dry kiln in the case of lumber. As time enters into all manufacturing operations, of necessity, these cases differ only in that the time element is greater than in some others.

In order to have all material in a stores accessible, it is not sufficient merely to provide for rapid handling of any particular article without disturbing other material, but exact information must be quickly available, at any time, as to the *quantity* in stores. While this may be obtained in some cases satisfactorily by actual measurement, when such information is wanted, it is generally necessary to provide a ledger of some kind, varying from a memorandum chalked on the wall near the material to an elaborate "card-system" which may be operated from a considerable distance. When reliable, this prevents the loss and annoyance due to overlooking material which might have been used or of finding the supply exhausted when it is wanted immediately. Considering the many forms which this record has taken in actual practice, there should be little trouble in selecting one which would suit almost any conditions.

Besides these general features, which apply more or less to all stores, those for machine shops are usually burdened with the duty of ordering a new supply of material as the stock of certain articles decreases, thus maintaining automatically a constant stock within certain limits fixed by the management. These limits are one of the most important features of such an arrangement, because if they are not great enough there occurs a constant loss due to shortage of material, or if they are too great, again a loss due to the idle capital which such a stock represents—often a large sum.

A graphical history of a stores, for the purposes of discussion, may be made as shown in Figure 1. This is really a graphical ledger account, for some one article, showing the balance or number in stock on any day during the time covered. The vertical lines which should represent Sundays have been omitted; a great help in using a calendar diagram of this kind. Material actually in stores, or "stock," is plotted above the zero line, while that for which orders have been received but no stock is available are plotted below. In general, these diagrams may be taken to represent finished machines or parts.

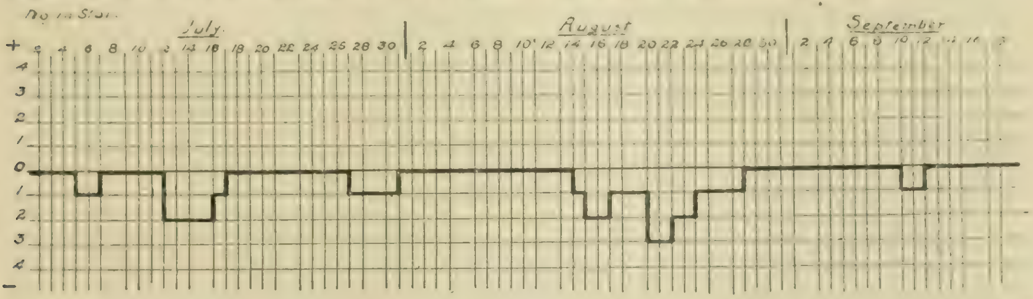


FIG. I. TYPICAL CHART OF STORES BUILDING TO ORDER ONLY.

From the time one of our "hairy ancestors" rudely fashioned a weapon for another "apeman," down to the present, the manufacturer has always if possible made certain that there would be a market for his wares, when complete. This is assured, usually, by obtaining the order or customer's promise to purchase. Under such conditions, no work is done and often no raw material is obtained until a customer is found. This is the case in Figure 1, in which the stores consists only of a record of machines to be "*built*" and perhaps material to be obtained.

When the demand for an article, instead of being spasmodic and infrequent as in Figure 1, increases and becomes fairly constant, the same course leads to "*manufacturing*" it as shown in Figure 2, in which, for convenience, the orders are all supposed to be received each day before the stock to fill them is turned into stores, although it may have been in work for days before. The production is assumed approximately constant at 285 pieces per day, and while the orders vary the average is about the same, so that the number in stores averages zero. When the production falls, for any reason, as on July 31, to 175 pieces, any small stock which may have accumulated is quickly wiped out.

This manufacturing in large quantities leads to the development of much special machinery suitable only for the production of a very limited range of work but wonderfully efficient within that range. This in turn reacts to increase the demand. Such cases have given the United States, especially the New England portion, credit for the devising of practically revolutionary methods of increasing output. Whether this success has been due to circumstances or to a peculiar aptness of the people for mechanical invention, in the same way that the Romans were especially gifted as law-givers, may be a question. There can be little doubt, however, that the conditions and the rich natural resources placed an enormous premium upon the ability to produce useful material results.

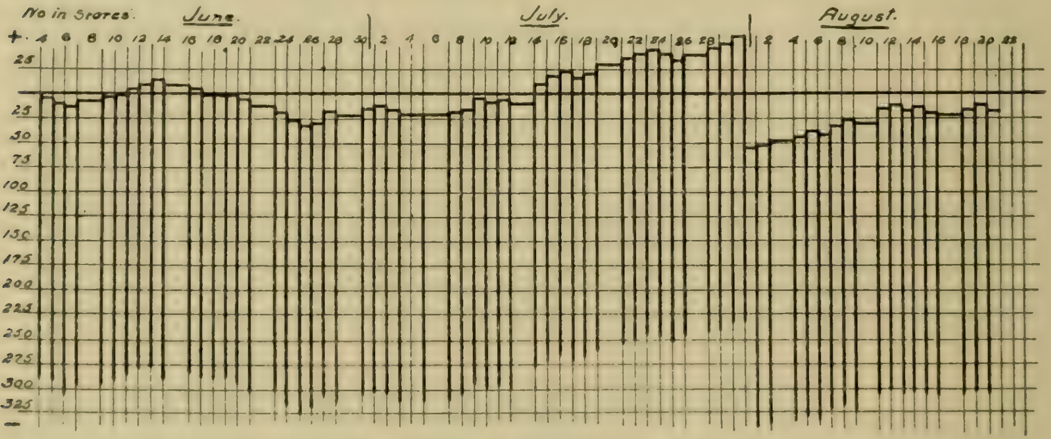


FIG. 2. MANUFACTURING FOR STORES, WITH FAIRLY CONSTANT PRODUCTION.

The low cost attained by the use of special means of production for articles in great demand, which may be called "*continuous manufacture*" when all the processes are in simultaneous operation, as in the case of a flour mill, naturally leads to the attempt to apply the same methods to articles for which the demand does not warrant the constant operation of an especial equipment. If however, as is often the case, the range of application can be made to include several articles, much alike, the equipment can be operated upon one of them for a certain length of time, then altered where necessary and operated upon the next, so obtaining the low productive cost for each in turn. While the reduction may not be as great as would be possible were the demand sufficient for continuous production, it is often a startling improvement over the previous method. The turret lathe is a typical example of such equipment. As a usual thing, the expense of preparing to make any given article, or "setting-up," is considerably greater than before, making it necessary that such expense be distributed over a number of pieces before any saving in the cost of each piece is effected over the older method.

Supposing the customer's orders to be for small quantities which individually did not warrant "setting-up," they might be allowed to accumulate as in Figure 3, in which case 40 pieces are completed at a time whenever customers have been found for them.

From the producer's standpoint this is the ideal method of obtaining the lowest possible cost, but the customer is seldom inclined to wait after his order has been placed until such time as the manufacturer can execute the work at the least expense, even though he may share the benefit in a correspondingly low purchase price.

So far it should be noted that no "stores," as a concrete place to store material, has been necessary. Only in the last case was the need for something of the kind particularly noticeable, and it is probable that the stores has been principally developed in the comparatively recent attempt to manufacture in large quantities, much more rapidly than consumption demanded—then to use the tools, perhaps for many months, on other work.

The delayed delivery necessary in Figure 3 may be overcome by manufacturing in advance of the orders and stocking as in Figure 4, or if the delivery need only to be shortened, the zero line may be at some intermediate point as A-B. The length of time which the "curve" is below the line A-B should in no case, however, exceed the allowable delay in shipping the goods to the customer.

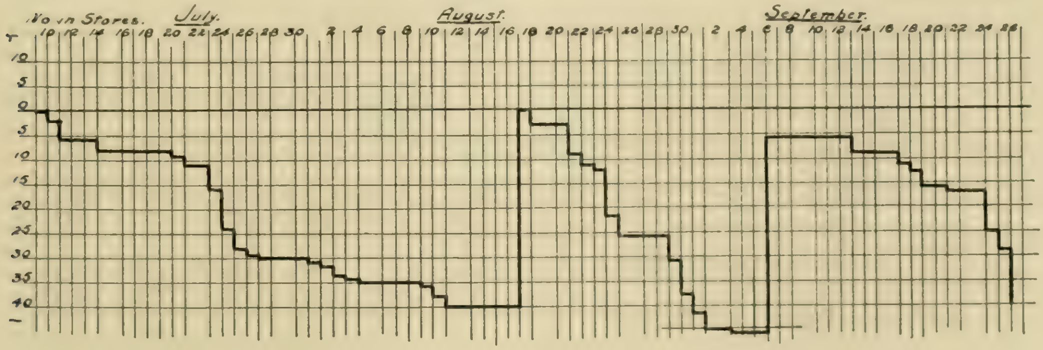


FIG. 3. CHART SHOWING MANUFACTURING FOR ACCUMULATED ORDERS.

Every article must satisfy the customer in the following three particulars. 1, design, which includes material, workmanship, etc. 2, price; and 3, delivery, or the time interval between the receipt of the customer's order by the manufacturer and the shipment of the goods. While the last has, for most articles, assumed particular importance only in recent times, it now often takes an equal rank with price. All these requirements are given to the shop or production department with the order as part of their instructions. While the design and delivery are not to be departed from in any particular, the "factory cost" may and should be made as low as possible. It is, in fact, the variable which measures the efficiency of the production department. These instructions to the shop (drawings, etc.) which are prepared first by the sales department, then amplified by the engineering, drafting, and specification departments successively, are theoretically the customer's description of the article ordered; the salesman acting as his representative and the engineering department as his engineer.

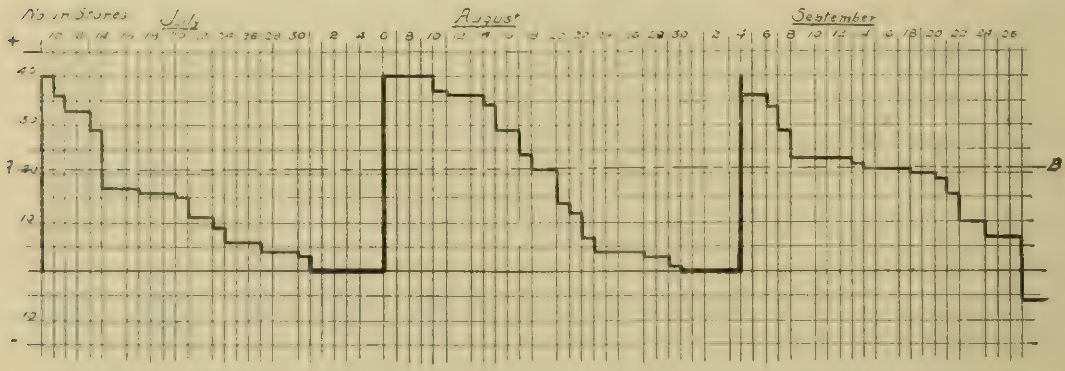


FIG. 4. CHART SHOWING STORES MANUFACTURED IN ADVANCE OF ORDERS.

A stores, from the production department's standpoint, may be defined as a machine or tool for shortening the delivery upon an article. It makes possible instant delivery in any quantity. In addition to those cases in which the instructions require a delivery impossible without a stores, the production department should, in all cases, stock any article, in any quantity, when the cost of production can thereby be reduced more than enough to pay for the cost of storage. This is the case in Figure 4. Suppose a delivery of three or four days, as in Figure 1, is satisfactory—long enough to make the article if the orders are taken individually. The article is stocked to meet this delivery and also allow of making in lots of 40, which greatly reduces the cost of each piece.

Referring, again, to the transportation parallel, it is seen that this last phase of the stores problem is very similar to one in which the production department has instructions to deliver a given article at a certain place, say A. If it is possible to manufacture it at A, no transportation will be necessary; if otherwise, it must be made elsewhere, say at B, and transported to A, the cost of transportation to be included in the final cost of the product. The production department should, however, be free to manufacture at any other place than B, say C, provided the cost at C plus the cost of transportation to A is less than the cost delivered at A from B, or made at A.

The conditions governing stocking imposed by the sales department, depending as they do on what the customer will purchase, are incapable of analysis; but those affecting the production department in reducing cost may be quite definitely worked out.

Figure 7 may be taken to represent a general case, for an article which it is necessary to have in stock with little chance of failure. In order to make the instructions to the stores definite, so that responsibility can be fixed in case of need, there are two quantities which once fixed will meet most requirements for the purpose of ordering material to renew stock. The first determines when it is to be ordered, preferably by reference to the amount of stock in stores, and the second determines the amount to be ordered. Perhaps the simplest way to connect the first with the stock is to fix a quantity which may be called the "base." This depends upon the delivery required by the sales department and may be fixed directly by them. When the stock falls to, or below, this base (G-Q, Figure 7) the order for stock renewal is issued for the quantity fixed for that purpose, G-A. This order quantity should be the most economical quantity to manufacture, as determined by the production department. If considered important, the quantity under way in the shop may also be taken into account, as is sometimes done in practice, but that is rather beyond the province of the stores proper. The supposition here is that when one order is isued, it is completed, and the stock replenished before another is necessary, although that is not necessarily true in practice.

The sum of the base and the order quantity is a true maximum, seldom reached in actual practice because stock is drawn from stores between the time the order is issued and the time it is completed. It serves, however, as a basis for figuring the amount of capital represented under extreme conditions. Usually the new stock is all received in stores at the same time, as shown by G-A, Figure 7, although that need not be the case. The time interval between two such events is not of great importance, but may be approximated by drawing a line A-B, from A, a point on the maximum line, and falling toward B at the rate equal to the average demand. The heavy broken line, showing the actual demand for that period in one instance, follows it more or less closely though it need not cross the base at the same point. A-B is simply the forecast of probabilities and the limits A′-B′, and A″-B″, may be drawn, if desired, to show, from past experience, how closely the actual demand may be expected to adhere to the forecast.

A-B need not be a straight line, for if the demand for a long period of time, say a year, is plotted, as in Figure 5, a relation between the season of the year or other factor and the demand may be

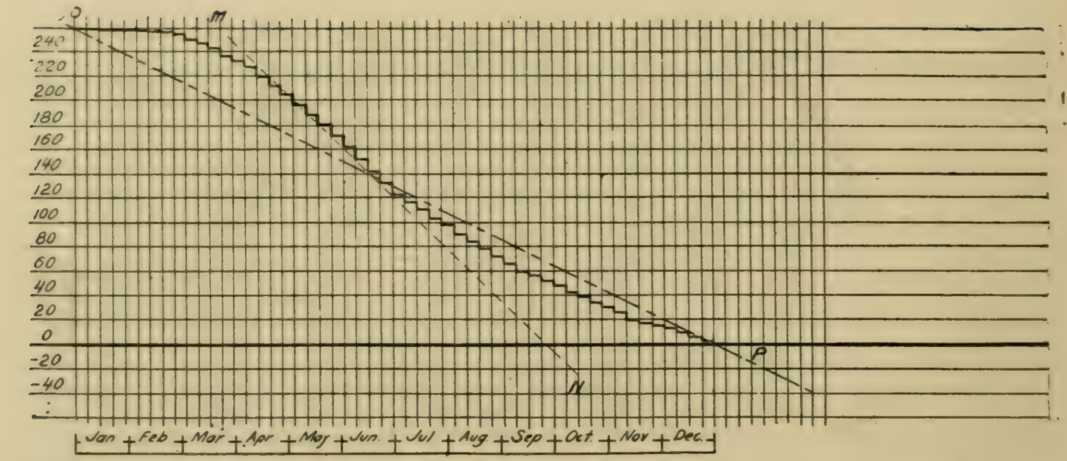


FIG. 5. CHART SHOWING SEASONAL DEMAND AND PRODUCTION.

observed, and in general such relations would be represented by curved lines. Figure 5 might show this for automobiles or ice-cream freezers. The maximum demand, M-N, is about twice the average, O-P, and the minimum is almost zero in January. Such a diagram would also show the extent of the fluctuations, as in Figure 6, in which A and B both have the same average demand but the fluctuations from that average are many times greater in the case of B. Really the only useful portion of these limits is the portion of A″-B″ below the base, which indicates, in all probability, the minimum time, Y-B″, which will occur after an order is issued for stock renewal, until the stock will become exhausted if not renewed. The average time required for production of the order may be laid off, as at Y-O, and a longer time, within which the completion is actually to take place, as Y-P. This date may be given to the production department. with the order, as part of their instructions and the matter brought to the attention of the management at that time if the stock has not been received. There would still remain the time P-Q, before the stock would fall to zero, as shown by the line A″-B″. The ratio of P-T to P-R may be called the, "factor of safety."

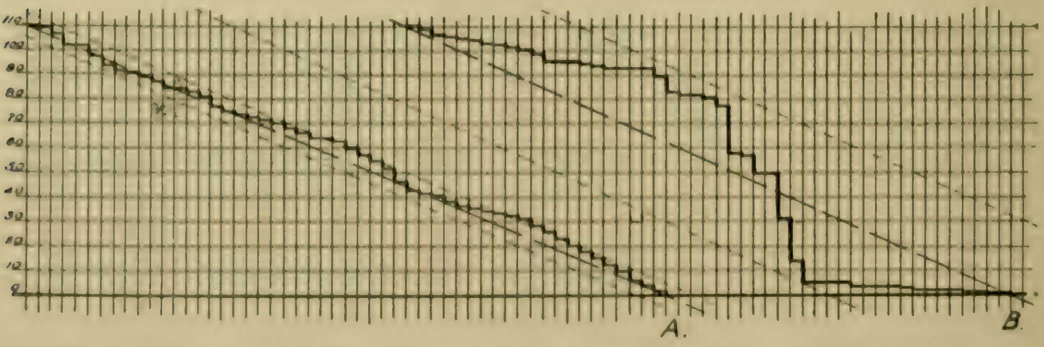


FIG. 6. CHART SHOWING FLUCTUATIONS OF DEMAND AS RELATED TO PRODUCTION.

The average number in stock may be calculated as one half the sum of A-S plus R-T, or U-V, and the average length of time each piece remains in stores, this quantity divided by the rate of demand shown by the line A-B, or V′-Y, if U′-V′ be made equal to U-V. In order to obtain the actual final cost of an article, the factory cost consisting of the labor and material should be increased by an amount sufficient to cover the expense of storing for the average time. If for simplicity this is figured as a percentage of the factory cost, probably accurate enough for material of the same general class, a diagram, Figure 8, might be used in comparing costs under different conditions. This percentage, compounded annually, should of course, be greater than that usually considered sufficient for interest upon capital by the cost of operating the stores, and enough should be added to cover the risk of the stock becoming damaged during storage or becoming obsolete in design. Taking for a basis the cost of the article when made as required (see Figure 1-2-3.) the extent to which the factory cost must be reduced when making arrangements for the article to be stocked may be read from the diagram in percent of the unstocked cost. Any reduction below this represents a lowering of the final cost of the article. For example, if the cost of stocking is 20 per cent per year of the factory cost, then the cost when made in such quantities as to give an average time of two years for each piece in stores must be reduced to 69 per cent at most of the unstocked cost. If the unstocked cost is unknown, a comparison may still be made between a tried and a proposed quantity for stock by using the diagram to find the difference which should exist between the factory costs so that the final costs may be the same. The production department may then determine, either by estimating or by actual trial of such an order quantity, whether or not the reduction can be effected. It might, also, be used

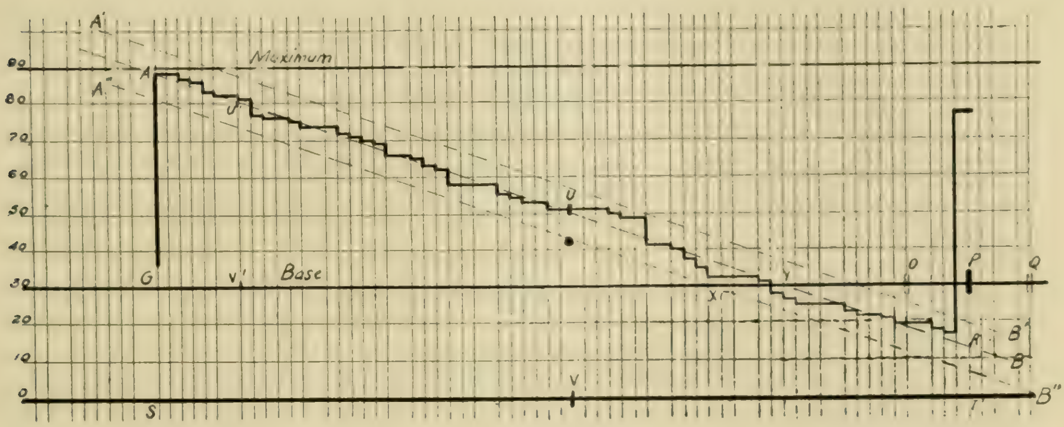


FIG. 7. CHART SHOWING MANUFACTURE WITH BASE, MAXIMUM AND MINIMUM LIMITS, AND ORDER QUANTITY.

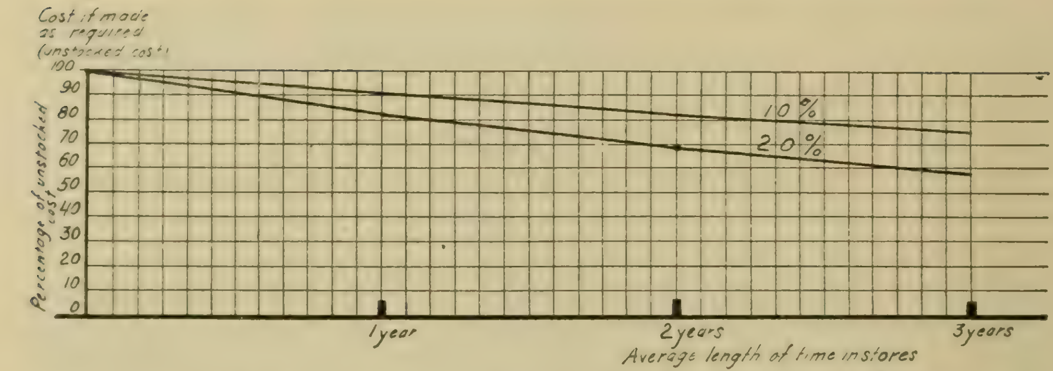


FIG. 8. DIAGRAM OF COMPARATIVE COST OF MANUFACTURING IN DIFFERENT QUANTITIES.

to show the reduction in purchase price of raw material to be obtained as larger quantities are purchased and necessarily stored for longer periods.

The base and order quantities in Figure 7, *may* be any whole numbers when machine parts are concerned, but usually only "round numbers" are used, as exact determinations of proper quantities are impracticable. In order to crystallize this tendency, it might be advisable to prepare a table of these numbers and allow no others to be used. Clerical work in cost accounting would be reduced if decimal numbers only are used.

Any table of this kind must necessarily be adapted to the service for which it is intended.

In order further to simplify the ledger work in the stores and elsewhere, each part is usually identified by some symbol, such as a number. There are several systems in use for this purpose and the same symbols usually serve both for the stores and cost systems, as well as the part list from which a customer orders spares.

In general, material is not stocked in continuous manufacture from the time the raw material starts through the manufacturing processes, until complete. All the operations being simultaneous, the average amount of material passing through any one can not be greater than that passing through any previous one, and if greater than that passing through any subsequent one the difference must accumulate indefinitely between the two operations. While, therefore, the maximum capacity of the different machines may be very different, the average must be the same and not greater than the least.

Intermittent manufacturing, however, presents a rather complicated problem, as an article may be stocked after each and every operation, although that is seldom desirable. Each stocking involves an expense for clerical work and transportation to and from the stores, independent of the length of time spent there. Therefore, the lowest final cost will be attained by stocking as few times as possible, other things being equal.

Most machine parts are completed separately, then assembled to form the machine. This may be represented by Figure 9. Any part moves, upon this diagram, vertically downward from the Raw Material Stores, A-B, upon the line bearing the identifying number for that part through the necessary operations, to the Completed Part Stores, C-D. The parts are then assembled as indicated, on the horizontal lines, one for each machine, identified by letter, finally reaching the Complete Machine Stores, D-E. All of these stores may be one and the same and located in any position in the works that is convenient. The fact that any part or groups of parts is stocked, is indicated at the proper point on the lines by a circle, as in the case of Piece No. 5, between the foundry and machine shop.

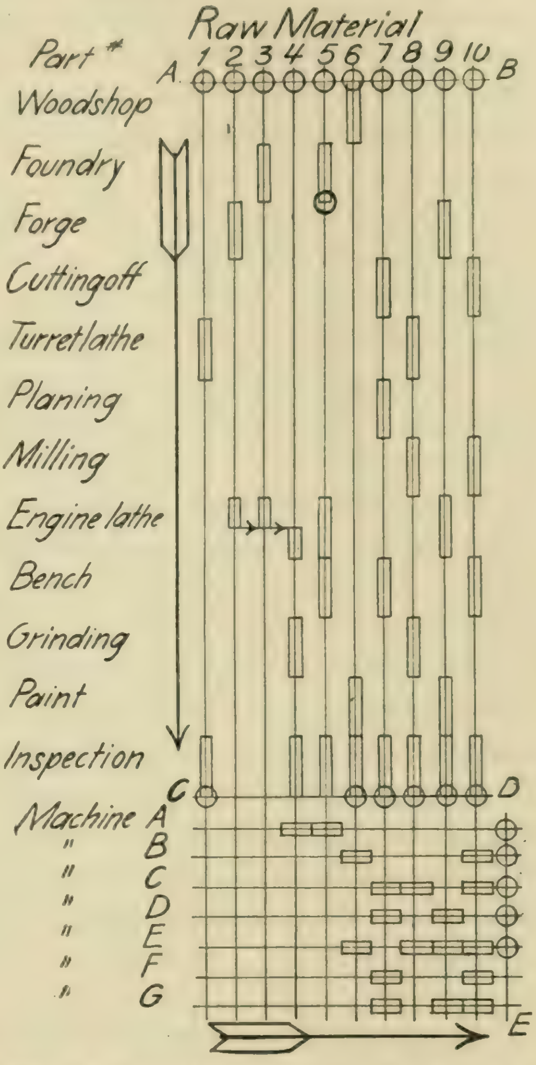


FIG. 9. DIAGRAM OF PROGRESS OF WORK THROUGH STORES.

While this is merely arranged as it is for convenience in using the diagram, it may be pointed out that the actual arrangement of some modern shops is similar. The erecting shop is situated, as shown by C-D-E, across the end of the machine sections, A-B-D-C. The arrows, in both cases, indicate the direction of crane travel, and in a general way the course taken by the material.

Roughly, it would seem that material should be completed as far as possible before stocking. A stores containing 1,000 pieces, ready for shipment, is less likely to experience a shortage of that article than is one containing 500 finished and 500 upon which one-half the labor has been expended. The cost of raw material is often a large proportion of the cost of the completed article, and after this material is once assigned to that article, and work commenced, it can no longer be diverted for the construction of any other article. In the second case just mentioned, the 500 pieces, half-finished, may represent three-fourths of the cost of the finished pieces, but they are unavailable for filling orders. They can, of course, be completed more rapidly than raw material, an important factor when that involves much time. As the expense of stocking may be divided into a fixed charge, plus a charge proportional to the time the stock remains in stores, it can easily be seen that it is cheaper to stock the finished article for six months than the finished and the half-finished article each for three months.

If necessary in order to keep enough work ahead for some of the departments, work which it was considered undesirable to keep on the floor near the machines might be turned into stores for temporary storage. In such a case the stores need not count or otherwise verify the number delivered, but simply receive the package for safe-keeping as is done with valuables placed in a safety deposit box. Such material would not appear on the stores ledger, but would be withdrawn by the department entering it whenever they were ready to work upon it.

Piece No. 1, Figure 9, represents say, a wood screw and is not stocked before it is completed ready for shipment. It is not used in assembling any of the machines, A to G.

In practice, it is often very desirable to stock ample quantities at several stages of completion—for example, rough castings, in order that there may be no delay or uncertainty about starting work in the machine department at the time planned. In this case, the cost of storage and the loss due to scrapping castings which become obsolete in design, in spite of the greatest care, are far outweighed by the advantage of being able to depend with reasonable certainty upon a scheduled delivery. The most erratic link in the chain is often eliminated with the foundry.

An operation in which several parts are united to form a working unit or assembling, is illustrated by pieces No. 2-3-4-5. The first two are, we will say, the rod and piston for a steam engine which are shrunk or riveted together during the engine lathe operation, then finished together, while the last is the piston ring. The numbers, 2 and 3, are not necessarily to be used as symbols for the rod and head, as both are united in No. 4; but as No. 4 and 5 preserve their individuality when assembled and can easily be separated, they should each be represented by a symbol. Provided that No. 4 and 5 are always required together, there is no advantage in stocking either separately, say at C-D, but they should be assembled in the way in which they are to be used and stocked at D-E. The raw material is then taken from the stores, in the proper ratio, say 1 rod, 1 head, and 2 rings, and carried to completion. Any departure from this ratio will cause an accumulation in the shop or stores of worked material which is useless until the material required to restore the ratio is drawn from stores and finished.

The most important practical bearing of this matter is when changes occur in design, which is remarkably often in many cases, and it is desirable to use all the pieces of the superseded design that may have been started before effecting the change. If the parts No. 2-3-4-5, were stocked at several stages of completion and without regard to the ratio in which they were to be used, it is very probable that many more of one piece would be found than of some others. There might be only 3 pistons and rods, but 150 rings which must either be scrapped or have pistons made for them—possibly a year's supply, so that the change could not be effected immediately.

Whenever an article is stocked several times before completion, care should be taken that the minimum stock is never less than the order quantity for any stocking which follows it, unless, of course, it is considered that the stock will have been renewed before another order quantity is drawn from that stock.

As distinguished from the assembling of several parts into one, it often happens that the same piece is used for assembling different machines, as No. 6-7-8-9-10. Any given piece follows exactly the course of all those known by the same symbol, until ready for assembling. Its final disposition may be any one of several machines, as No. 6 in machines B or E. If these are sold in different and fluctuating quantities it might happen, in emergency, that to obtain piece No. 6, for completing machine E, machine B, would have to be taken apart. A stock of pieces No. 6, at C-D, would prevent this and allow of their being held at this "parting of the ways," ready for use wherever required. As assembling, in general, requires but little time, it would seem preferable to stock as large an amount of finished parts as necessary where they were used in more than one way and a comparatively small stock, possibly none, of the assembled machines. Machines F and G illustrate cases in which the time allowed for delivery is long enough to assemble the parts stocked at C-D.

In the same way, if goods were made in New York and sold in both St. Louis and Milwaukee, one stock at Chicago, near enough to fill orders quickly, would be better than a stock at both the places, in which latter case it might easily happen that goods would have to be shipped frome one to the other, through Chicago. This is especially true if the supply is scarcely equal to the demand and the latter is fluctuating.

The peculiar case sometimes occurs of pieces which are ordered by customers for spares to replace those lost or broken and which are not stocked separately. If this occurs often enough, a small number may be stocked if care is taken that they are not drawn when assembling stock machines. When a lot of machines is started enough should be made to complete that lot.

Groups of assembled parts can often be stocked to advantage, a thing which seems to be overlooked in some cases, the groups being so arranged that the more complex are obtained from the simpler ones by adding stocked parts, even when this requires additional machine work or the slight alteration of work already complete. For example, motor-starting resistance require face plates with or without a number of small pieces of apparatus such as maximum or overload release, etc. These face plates can be stocked and the unusual features added, or even some of those affixed can be removed; this greatly reduces the necessary stock of completed face plates. As the fastening screws are very likely to vary, in length at least, these are not stocked with the face plates but drawn as required. Small articles of this kind are very seldom returned to stores when not required, and so are lost or misused.

In the case of the face plates, the punchings, etc., were stocked separately in far greater quantities than the number of face plates required, because the production department could in that way reduce the cost; but the castings which were not made on moulding machines were ordered in large enough quantities only to meet requirements.

In general, then, as the greatest trouble in modern manufacturing appears to be shortage of material and so inability to make satisfactory delivery, it appears that attention should be turned to the stores as the proper mechanism for overcoming the trouble. While an article may necessarily be stocked to meet the delivery required by the sales department, it may be stocked in any greater quantity if cost can be in that way reduced.

An article should be stocked only when there appears an advantage in so doing; otherwise it should be carried toward completion and stocked as a finished piece, or still better in an assembled group of parts or in a machine. When, however, it may be used in more than one way, it should be stocked before rather than after its disposition is determined.

COST REDUCTION THROUGH COST COMPARISON.

By C. E. Knoeppel.

III. THE ORGANIZATION AND FUNCTIONS OF A COST-REDUCING DEPARTMENT.

Mr. Knoeppel's series began in our March number. His initial article discussed the record of burden costs, and his second installment took up machine, part, group, and operation cost comparisons. The paper now presented concludes the series.—The Editors.

THE discovery of new methods of processing; the inventions of more efficient machine tools; the designing of better jigs; the introduction of higher cutting tool steels and cutting compounds; the eager search for more efficient methods and the enormous amounts paid to those who can devise money-saving systems, these all point to one significant fact—the desire for maximum efficiency. Some years ago the only question thought of was: "What are we doing?" Today it is : "What are we doing, what have we done, and what can we do? Some years ago desires were backed by experience; today they are backed by experience plus facts and figures. Some years ago "effects" received the greatest consideration; today it is "effects" and what caused them.

Modern business is no longer the game of chance it used to be. There was a time when a man could conduct his business on the "hit or miss" principle with some degree of success, but this policy cannot be practiced today; and while a number of concerns, classed as successful, are doing business without the assistance of the best equipment and methods obtainable, it is not *because* of this fact but rather in *spite* of it. The time is coming, if it is not already here, when the executive, in order to make his business a success, must so systematize his every detail as to enable him to see the end from the beginning. He will have to know where and how he is going—what he is doing and the why of it all, which means that he will know where his losses cease and his profits begin. Anyone can say "something is wrong," but the importance of being able to say "here is the fault" cannot be over-estimated.

What has caused the subject of "cost finding" to receive the attention it has from able writers? Why have the leading magazines, the various conventions of manufacturers, and the yearly meetings of technical and other societies, given up valuable space and time to its discussion, and what has made necessary the advent of the "production engineer," "systematizer," "auditor" and "accountant"? Presumably the primary reason is the desire on the part of the manufacturer or business man so to conduct his business that the maximum output and profits may be secured. This being the case, why has the desire to achieve this ambition brought about the particular results outlined above? The underlying causes are, first of all, the complexity of modern business practice; the fact that each case presents its own peculiar conditions; the inability on the part of the executive to give the time to the study of his conditions or to the application of better methods, and the fact that the manufacturer does not care to experiment—he wants to feel sure that whatever is introduced will be accurate and productive of the most good. It therefore follows that the manufacturer realizes the importance of a system carefully devised, properly introduced, and wisely operated, and the keystone in this system must, of necessity, be an efficient method of cost finding in order that a reduction of the costs may be brought about. Inasmuch as the value of any system of costs is in proportion to the results obtained by it, the next question that suggests itself is—what must such a system accomplish in order that it may be pronounced successful? This can best be answered by reducing any system of costs into its fundamental elements, as follows:

COST SECURING.—The gathering of the many details through the instrumentality of shop orders, material requisitions, time cards, etc.

COST COMPILING.—The entering of the details secured upon forms and reports provided for the purpose.

COST COMPARISON.—The placing of the latest information and data under or beside other information and data of like nature.

COST ANALYSIS.—The thought and deduction applied to the cost comparisons.

This will show that in order to reduce a cost, it must be analyzed by comparison; this depends upon proper compilation, and all again depends upon accuracy in securing the cost data.

No doubt every person who reads this article will know of one instance, perhaps several, where a cost system had been devised and installed, allowed to run for a time, and finally thrown out on account of its failure to cut costs; the result being that the mere mention of the word "system" has about the same effect on that manufacturer as would the flaunting of a red flag in the eyes of a bull. In other cases systems have been pronounced failures but yet allowed to run on as best they could. A consideration, therefore, of the reasons why so many systems have failed to accomplish results would be next in order. The truth of the matter is that when systems have been thrown out or pronounced unsuccessful on account of their inability to perform their proper functions, their expensiveness, or other objections, an investigation would show, in the majority of cases, that the manufacturer himself and not the system was to blame. This may be due to one or more of a number of reasons, the most important one perhaps being business procrastination—or the inability on the part of the manufacturer to give more than passing attention to the points that vitally effect his business success; or, to put it another way, he is so engrossed by the consideration of details that *must* be attended to that the details that *should* be attended to are left to a more convenient season. In his leisure moments—if he has any—he may pick up a magazine that contains some valuable suggestions; at his convention he listens to a paper and discussion that appeals to him; but in his endeavor to secure business, to meet his obligations, to collect amounts due him, etc., the application of short cuts, better methods and suggestions is lost sight of for the time being. As a result, while the costs may be found and recorded, no practical use is made of the compilations. The system may be an excellent one, perhaps installed by a systematizer and capable of giving maximum results; but the best cost keeper in the world will soon lose heart when he realizes that his work does no real good. It may be, owing to the inability of the management, that several people have something to say about the costing, and unless they can all agree on a uniform policy (something quite unusual) the matter of using the cost compilations is out of the question, as the statements are bound to be misleading.

Another course which leads to disappointment with cost-keeping efforts is taken by some manufacturers who think that by putting in a few loose-leaf books, some cards with cases, and a few clerks to look after the records, they should obtain the desired results. A system in itself can do nothing, even with a bright clerk in charge, unless the co-operation of all concerned can be secured—a point oftentimes lost sight of. If A tells B to do a piece of work and B is dependent upon C for his information, it is impossible for B to force co-operation from C unless A has told C that the instructions of B are to be carried out. Another reason for the failure of a system to give results is sometimes found in the fact that it is experimented with—

patched and altered every time a new man takes charge. It is impossible for a concern to get results from a system radically changed from time to time, owing to the inability to compare items of like nature. To recapitulate, the causes of failure can be classed under the following headings:—

The application of systems that do not cover the conditions as they should.

Inability on the part of the management to give the systems and their workings the attention that they should.

Lack of co-operation among the heads of departments.

Too many changes.

Inefficient organization.

The question therefore suggests itself—how can these defects be obviated and how can the work be so handled as to result in maximum efficiency? After careful consideration, I am of the opinion that the answer of this question should be—the introduction of what may be called a "Department of Cost Reduction," in charge of a competent man who has supervision over and gives his whole time and attention to the securing, compilation, comparison, and analysis of costs, along with such other information as affects the success or failure of the enterprise. Before proceeding to elaborate upon the possibilities of this department, it is advisable to devote a few words to the qualifications and the authority of the man in charge, and to suggestions as to where he can get his information, with a brief list of possible compilations.

The chief qualification necessary in the man who is to manage this Department of Cost Reduction is the ability to take whatever information and data come to him and so to arrange and compile them as to enable him to use the data to advantage. Information is valuable in proportion to the facility of its comparison with information of a like nature, so that an important faculty in this man would be his ability to dissect the information and data he received as a surgeon would dissect a body, and then to reduce it in about the same manner as a mathematician would reduce a row of figures to a common denominator. Once dissected and reduced, it is an easy matter (provided the man in charge has some ability as a statistician) to draft statements that will aid in reducing costs. The ability to compile and to analyze should be accompanied by fearlessness in submitting his results; and if he is a gentleman in his dealings with his fellow men, the success of a department along the lines suggested will be productive of the desired ends. The truth sometimes hurts, but if made known in a gentlemanly manner the sting is often removed.

To secure maximum results the manager of this important department should be independent of everyone with the exception of the president or general manager, in order that his suggestions and the results of his analysis may be properly taken care of. He should have full supervision over the compiling of all the available data as well as over the methods for securing these data. He should have the authority to secure any data of a special nature from any department of the business. He should have the right to lay the results of his investigations before the proper persons, and to expect that these results will be properly considered; and lastly, it should be understood that while he is to have no authority over anyone excepting the clerks who secure, compile, and classify the information he desires, his requests should be complied with; for in the exercise of his duties he deals with effects and results, and he must depend upon the co-operation of all in his attempt to find the underlying causes—the means whereby costs can be reduced. If the management will give these directions, no one will attempt to antagonize the man in charge of this department except one who might be afraid to have the results of his work known.

The data and information to be compiled by this "Department of Cost Reduction" or under its supervision are procurable from three main sources—shops, accounting, and sales departments, as follows:

FROM SHOPS.

Time spent on productive orders.
Time spent on general orders.
Material drawn on productive orders.
Material drawn on general orders.
Weight of materials shipped monthly.
Shop rejections.
Materials returned on account of defects, errors, etc.

FROM SALES DEPARTMENT.

Salesmen's expense books.
Salesmen's reports showing sales and to whom; lost sales by machines and to whom, etc.

FROM ACCOUNTING DEPARTMENT.

Sales by classes.
Purchases by classes and kinds of material.
Cost of collection.
Cost of advertising.
Burden expense such as taxes, insurance, salaries, depreciation, interest and discount, etc.
Freight and express bills.
Monthly balance sheet.

The possibility of this department becoming immensely productive as a factor in the reduction of costs can be readily appreciated if any person interested will stop to consider what the following data may mean to his business, providing the department is properly managed and the information used as it should be. The extent of the records will of course depend upon the size of the business, for a small concern would not need as extensive a list as shown, while a combination of concerns would perhaps desire an even more extensive one:—

Cumulative, average and monthly sales, with comparisons.

Cumulative, average and monthly sales by classes of machinery, with comparison.

Monthly sales by salesmen.

Monthly salaries and expenses of salesmen.

Materials returned, according to territory.

Record by department of materials returned owing to defects or errors.

Lost sales by salesmen.

Lost sales by machines.

Lost sales according to successful competitor.

Loss from bad accounts.

Cost of collection and advertising.

Record of the various classes of purchases each month, showing the departmental, productive, and maintenance materials, material for the drawing room, offices, plant betterments, etc., with comparisons.

Record of the various kinds of materials such as pig irons, cold rolled steel, tool steels, babbitt, cutters, etc.

Cumulative, average, and monthly shipments in pounds.

Departmental productive and non-productive rates per hour.

Cumulative, average, and monthly burden statements, with comparisons.

Record of rejected work by department.

Monthly balance sheet, showing increase or decrease in assets and liabilities over the previous month and over the same month of the previous year.

The cost of operations, with comparisons.

The cost of parts, with comparisons.

The cost of groups, with comparisons.

The cost of machines, with comparisons.

The cost of contracts.

Record of sales by machines showing the gain or loss.

We will suppose that a department such as I have suggested has been introduced by a manufacturing enterprise, a competent man placed in charge, the organization arranged so that he has the authority to secure whatever data he may require. After a few months run, what may one expect from this department?

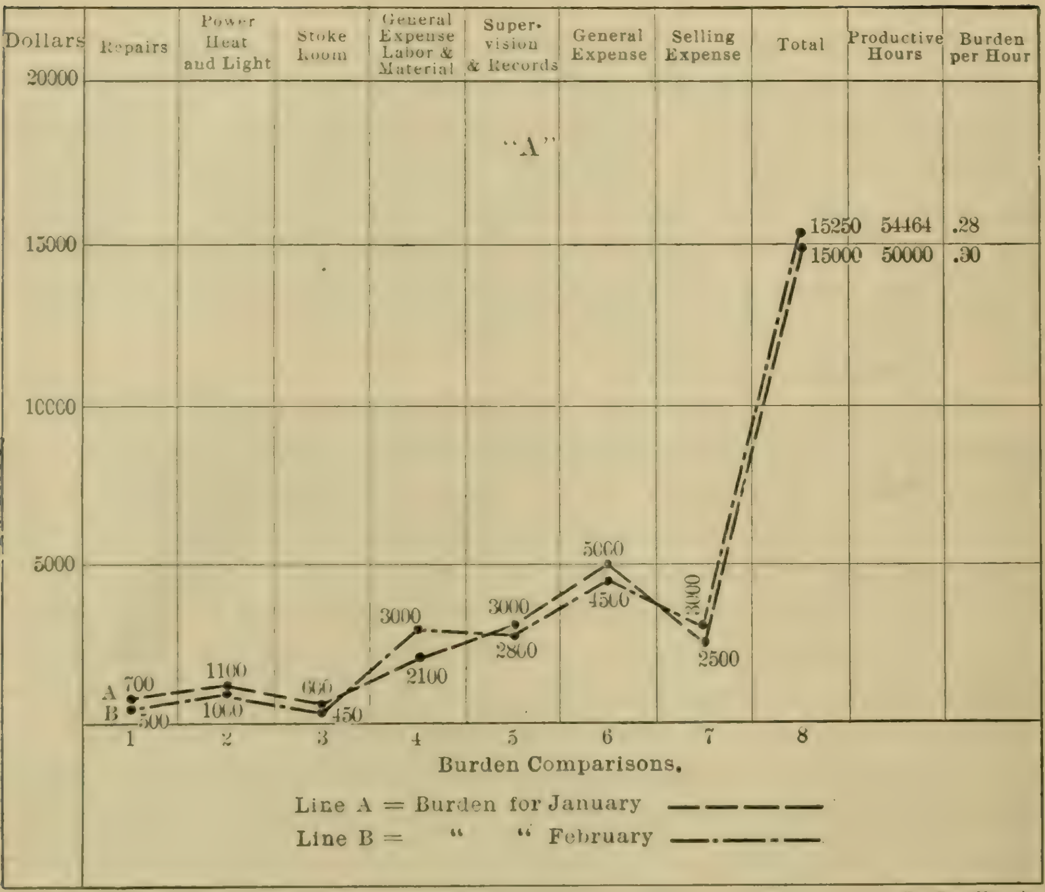
From the salesmen's reports, this department will have secured all the information it can regarding "lost sales"—who lost the sale, the territory, the date, the name of the successful competitor, the name of the article or machine, the amount of the lost sale, and the reason for its loss. All this information can be so arranged and classified as to show which territory needs the most attention—the salesman who is losing the largest number of sales—what competitor is making the greatest inroads on the business—what machines are hardest to sell and why. We will suppose that the compilation of lost sales by machines and their reasons is receiving the attention of the manager of this department. He notices that the lost sales on the "X" machines amounted to $20,000 for the following reasons—

They are unsatisfactory in their work;
The price is too high.

This attracts his attention, and on turning to his file of sales by machines showing costs, profits, and losses—(Form F, page 78, THE ENGINEERING MAGAZINE, April issue)—he finds that there is an excellent margin of profit on the machines which have been sold, and concludes that if the price can be lowered and an effort made to overcome the fault in the machine, the company stands an excellent show of regaining its losses. It also occurs to him to look at the machines that sell the best, which might show him that the price is so low and the margin of profit so small as to admit of easy sale. He can also take up the investigation of sold machines on which losses have been incurred, and by investigating the question of design, costs, prices of competitors, etc., with the one higher up, these compilations of sales and lost sales at once become of great assistance in increasing business as well as profits.

Upon finishing his burden report for February and entering it upon a comparative sheet as shown in Form A, he notices that the burden per productive hour was less by $0.02 than in January, although in money it increased $250.00 which in itself is not a "startling" increase. As the business of the man in charge of this department is to analyze, he begins to note the various increases and decreases; he finds that in columns 1, 2, 3, 5, and 6 the money expended was less than during the previous month, but in column 4 the increase was $900.00 and in column 7 $500.00; while these increases may be legitimate, it remains for this fact to be proven by an investigation (as described in my article in the March issue of this Magazine) which might prove—as it often does that it does not pay to jump at conclusions.

The manager of this department, we will say, has compiled records according to the kinds of materials such as babbitt, cold-rolled steel, coal, etc. On a certain morning a salesman representing a babbitt house steps into the office, and after demonstrating the superior qualities of the babbitt, the manufacturer decides to give



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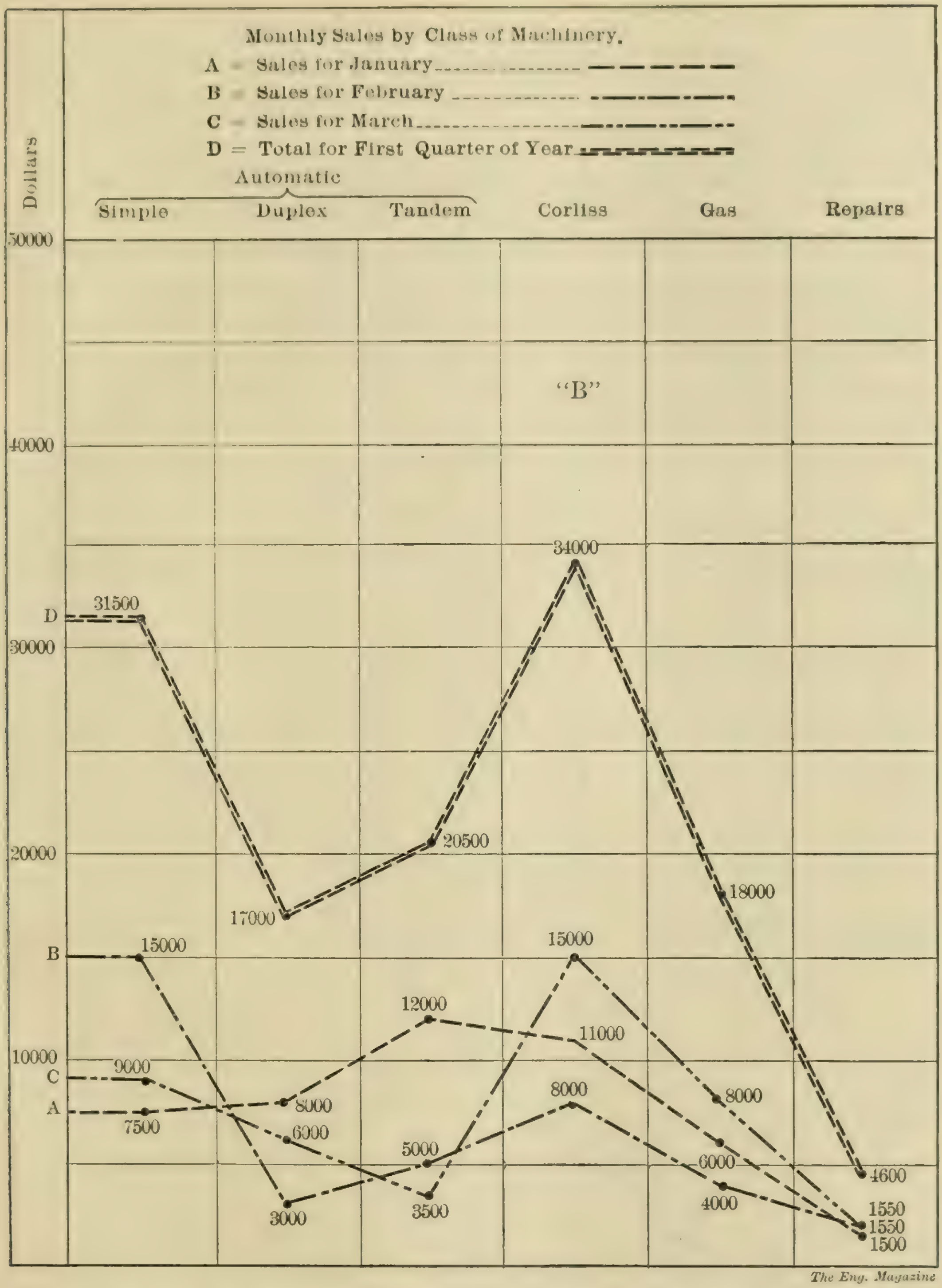
FORM A. COMPARATIVE DEPARTMENTAL BURDEN, BY MONTHS.

him an order. He asks the manager of this "Department of Cost Reduction" if he can give him the approximate amount used in a year; it is only the work of a moment to find from his records the average consumption by classes, which he hands to the manufacturer; from this list the latter finds that he uses about 15 tons of genuine babbitt yearly, so instead of giving this salesman an order for a few kegs, he buys a large quantity on which he saves quite a little. The classification of such items as novo steel, belting, reamers, drills, drawing-room papers, etc., in this way would often enable the manufacturer to purchase more reasonably. It takes time, to be sure, but consider the possible saving.

An analysis of the comparisons as shown on Forms B and C might be productive of desirable results. Take Form C for instance. The manager, on looking over the monthly sales, noticed that the sales dropped from $43,050 in March to $31,000 in April, although the trend from then until August was steadily upward. In September, however, a slump occurred, the decrease being $21,000. By looking at the record of Form B for the proper months he could



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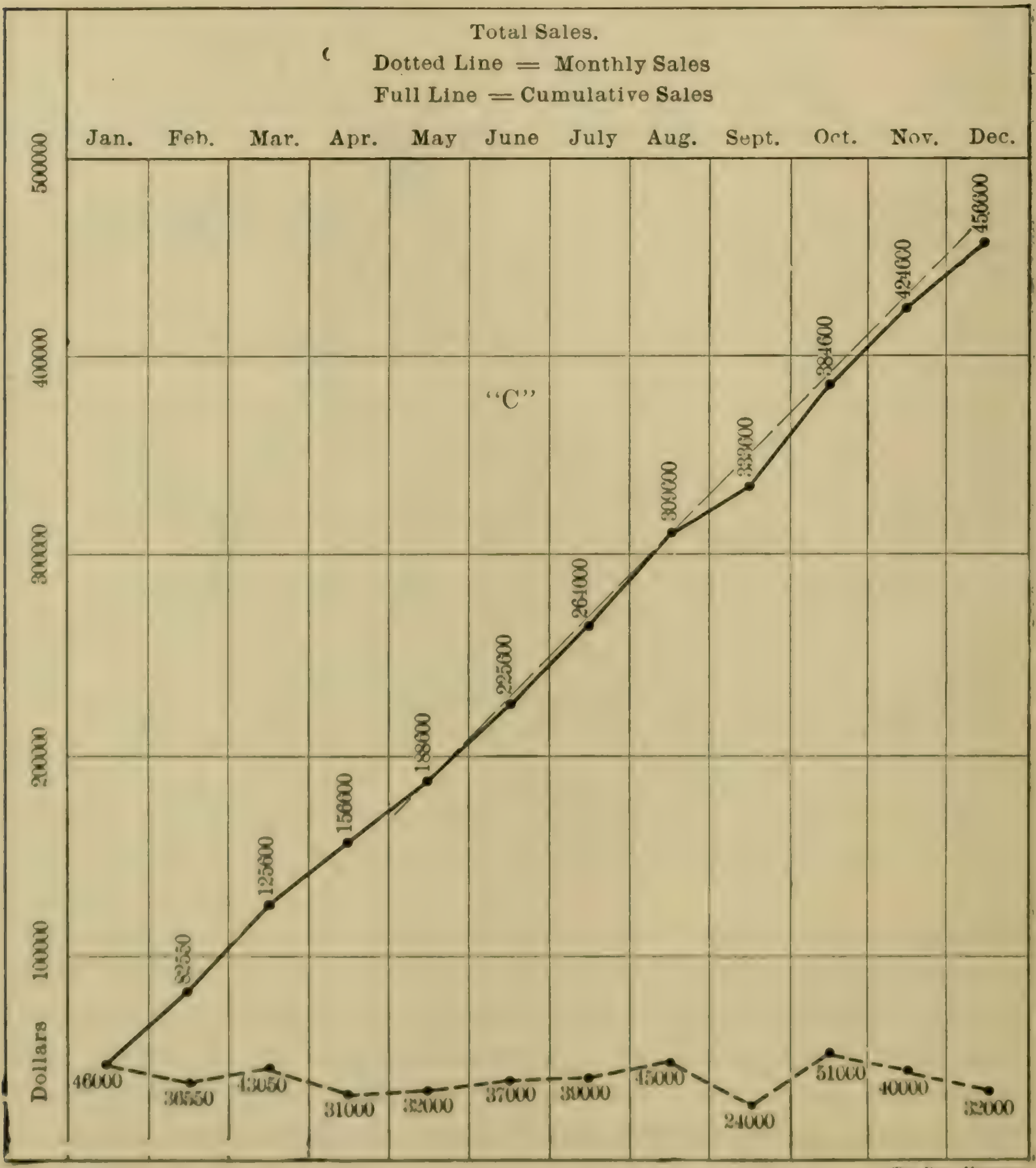
FORM B. COMPARATIVE SALES, BY CLASSES OF PRODUCT AND BY MONTHS.

find the class of machinery that was responsible for the slump, and from there he could take up the investigation of his burden for the month, the record of lost sales, and the sales by machines, all of which would perhaps enable him to locate the cause of the slump.

A record as shown in Form D might enable the management to determine whether the amount spent for repairs was in proportion to the investment or not. If not, they could easily trace back and locate the machines or buildings that required the most repairing, and by putting them in the best possible shape, might considerably reduce the repair expense.

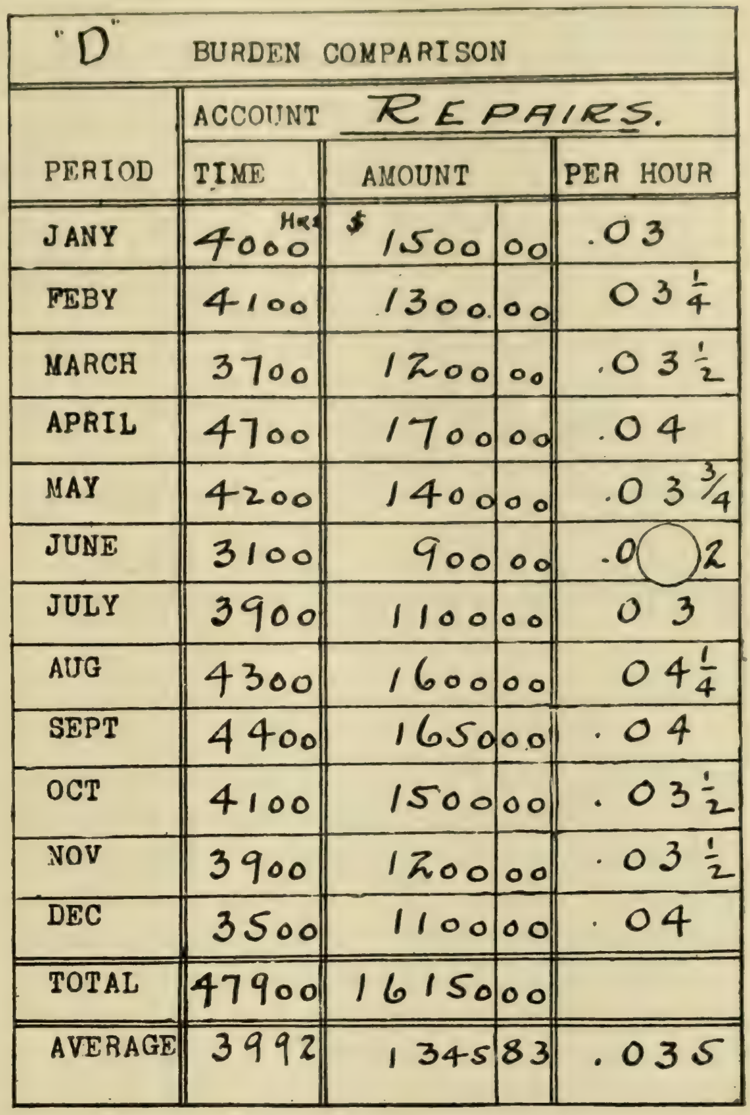
As the selling expense is a large item, this department naturally undertakes the compiling of data secured from the salesmen's expense books which will show the amounts expended by each salesman for mileage, sleeper, hotel expenses, etc.; while a salesman is not responsible for the first two items he is for all others, and by totaling the net expenses, and dividing by the number of days on the road, the salesman's average daily expense can be determined. Adding his net



The Eng. Magazine

FORM C. COMPARISON OF TOTAL SALES.

expenses to his salary and his commissions will give a sum which, divided by his sales during the month, will result in the per cent of cost. This information, in conjunction with the information regarding his lost sales, the returned materials from his territory, and the complaints, etc., will enable the sales manager to pass upon the efficiency of his salesmen as well as furnish the means whereby sales costs can be reduced.

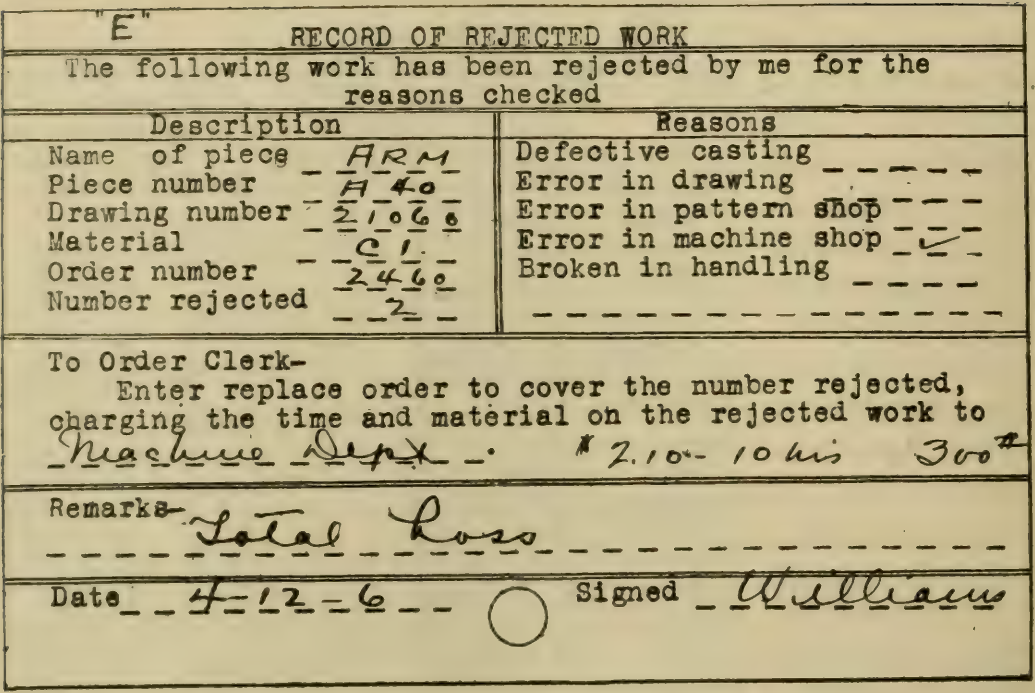


"D" BURDEN COMPARISON

PERIOD	ACCOUNT REPAIRS.			
	TIME	AMOUNT		PER HOUR
JANY	4000 Hrs	$ 1500	00	.03
FEBY	4100	1300	00	03¼
MARCH	3700	1200	00	.03½
APRIL	4700	1700	00	.04
MAY	4200	1400	00	.03¾
JUNE	3100	900	00	.0 ○ 2
JULY	3900	1100	00	03
AUG	4300	1600	00	04¼
SEPT	4400	1650	00	.04
OCT	4100	1500	00	.03½
NOV	3900	1200	00	.03½
DEC	3500	1100	00	.04
TOTAL	47900	16150	00	
AVERAGE	3992	1345	83	.035

FORM D. COMPARATIVE RECORD OF REPAIRS.

After the "comparative cost reports" (See Form E, page 81, THE ENGINEERING MAGAZINE for April, 1907)—are returned to the department of cost reduction they can be filed according to department and workman. This file will enable the manager to tell whether or not the department foreman is giving the proper attention to the men who need the most watching. The efficiency of the workmen can soon be determined; for if a man is a good one, the reports showing increases against him will be few and the necessary attention can be concentrated upon those men who have a large number of these reports against them. Form E—next page—filed by department and used in conjunction with the above file, will be instrumental in causing the shop management to exercise the best of care. Men are sensitive regarding errors made, and if compilations can be



"E" RECORD OF REJECTED WORK

The following work has been rejected by me for the reasons checked

Description		Reasons	
Name of piece	ARM	Defective casting	
Piece number	A 40	Error in drawing	
Drawing number	21066	Error in pattern shop	
Material	C I.	Error in machine shop	✓
Order number	2460	Broken in handling	
Number rejected	2		

To Order Clerk-
Enter replace order to cover the number rejected, charging the time and material on the rejected work to
Machine Dept. $2.10 - 10 hrs 300#

Remarks- Total Loss

Date 4-12-6 ○ Signed Williams

FORM E. COMPARATIVE RECORD OF REJECTED WORK.

laid before them showing rejections for which they are to blame, it stands to reason that in their desire to retain their positions they will attempt to keep the rejections at as low a figure as possible. These same cards can also cover the return of materials due to errors and defects whether they have to be replaced or not.

Many other illustrations could be given to show the practical workings of this department, but the length of this article renders more elaboration inadvisable. Before closing, however, let us see what the possibilities of this department are if conducted along right lines. In the first place one man, under the supervision of but one man, is giving his whole time and attention to the work of collecting the numberless details of the business—the great advantage being that we have all the information in one place, all wound on one spool; and the result of arranging, classifying, and compiling these details is a statistical bureau containing valuable information concerning prime and burden costs, sales and lost sales, purchases, efficiency of salesmen, workmen, and the shop management, earnings, etc—all of which, properly analyzed, places in the hands of the executive the whip with which he can enforce the desired results. Back of this whip is the hand. Guiding this hand is the knowledge made possible by information which is "current history," and which has been properly analyzed under the best of conditions The only result possible is—Cost Reduction.

EDITORIAL COMMENT

A MOST commendable outcome of the exposition of safety devices and industrial hygiene, held in New York last winter by the American Institute of Social Service, has developed in the plans for the foundation of a permanent "Museum of Security." It may be said of many occupations, as Mr. Nixon says elsewhere in this number of the marine fire-room, that the frightful conditions "have been so long looked upon as necessary evils that the pitiable life . . receives but little attention." Those most constantly in contact with such conditions seem to become most imbued with the conviction that they are inevitable. Employees steeled to endurance pass easily into recklessness. Employers schooled to indifference descend to callousness. The age of brutality in works management has given place to one far more enlightened, but there are still superintendents, like the one recently quoted by Mr. Becker in these pages, who can meet the advocate of a safety device with the exclamation: "Hell! fingers don't cost us anything!"

To the majority of us, impressions received through the eye are the most vivid. Argument, description, statistics, are weak in comparison with concrete instance and object lesson. Herein lies the power of the museum. It convinces of the evil and at the same moment exhibits the remedy. It is a continuous educational force, limited in range at first, but constantly widening. We do not share the scepticism as to its value recently expressed by our excellent contemporary, *Engineering News*. We believe it will give new impetus to a tendency which has already received much attention and acceleration through articles published in this magazine—the movement for the betterment of industrial environment, for the "square deal" for the workman. It is a movement which, in our view, must get its force from the moral and intellectual conviction of the employer. It is he who, in the language of a recent public speaker, must "teach the worker to value his own life." The worker so taught will be a better, a safer, and a more responsible employee. No one need fear that such effort is mere visionary altruism. It is soundly utilitarian. The argument can hardly be put more concisely than it was by H. F. L. Orcutt, in his remarkable series of articles on machine-shop management published in this magazine eight years ago:

"First, last, and always should manufacturers remember that it is economy as well as humanity to plan factories 'in which human life is of more account than machinery'; into which human beings will not be driven by hunger, but attracted by superior hygienic surroundings—air, light, comfort—as well as by the most modern equipments for saving labor, increasing output, and raising the standard of workmanship and wages." In short, it pays.

* * *

A KINDRED effort, of more closely individualized purpose but of larger field, is that which is being actively pushed by the Committee on the Prevention of Tuberculosis of the Charity Organization Society of the city of New York. Their object is a systematic campaign of education, first to convince those who should be interested that the disease is preventable, and second to teach simple rules by which it may be avoided or its ravages may be checked. The annual "economic waste" in the State of New York alone from this one cause is said to be 14,000 lives and $30,000,000. While some of the sources of origin concern the public at large, it is unfortunately true that others center peculiarly in certain defects too frequently characteristic of our manufacturing establishments; and that some such plants are breeding grounds for the disease, menacing not only their own workers but the whole community. In general the ideal conditions for resistance to tuberculosis are light, open air, and abundant nutrition. The literature of the committee points out how the most favorable conditions for the prevention of infection may be obtained by practical measures, and is well worth study. We believe it may be secured by application to Paul Kennaday, secretary.

* * *

"THE safety of society;" said Mr. Carnegie in his address at the dedicatory exercises of the new home of the United Engineering Society, "lies in the fact that in any enterprise for good there is always consolidation and co-operation," and this remark sounds the key-note of all the addresses delivered on that occasion. The union of the engineering societies was hailed as an event of remarkable significance, indicative of the beginning of an era of larger and greater engineering achievement in this country. The same speaker also made the statement, rather remarkable in view of the facts, that "all the engineering societies of America are really one band." It is doubtful, however, whether a consolidation of the various engineering societies is, at the present time, either desirable or possible. Since the separation of the societies devoted to special branches of the engineering profession from the parent stem, there has been no alteration in the industrial conditions which made separation advisable. There is today the same demand for the specialist, a demand which the passage of time has served only to intensify, and of whose cessation there are no present indications. At the same time, however, the interdependence of the various branches of the engineering profession has become more and more apparent. It is now fully recognized that the electrical engineer must have mechanical knowledge, that the mechanical engineer must be thoroughly familiar with the applications of electricity, and that the mining engineer must be prepared to apply, in his work, at least the fundamental principles of almost every branch of applied science. It is here that the strength of the United Engineering Society must lie; not in the attempted consolidation of the various branches, of special interests so diverse though interdependent, but in the increasing of facilities for free and full interchange of ideas. Co-operation, not consolidation, must be the basis upon which the Society is to attain to greatest usefulness and influence—co-operation in the advancement of engineering knowledge, in the maintenance of standards of professional ethics, and in the raising of the profession of engineering to its rightful place in the eyes of the world,

* * *

THE very large amount of work attending the preparation of Mr. C. U. Carpenter's article on the determination and introduction of "standard times" for machine-tool operations—the next installment in his current series—made it impossible to reduce the materials to final form in time for inclusion in this issue. The enforced interruption of one month, however, we believe will be compensated for by the value of the discussion which will be resumed in our June number, and we hope will be continued thereafter without further break.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE RAPID TRANSIT SYSTEMS OF LONDON.

FEATURES OF THE DEVELOPMENT OF TRANSPORTATION SYSTEMS WITHIN THE BUSINESS DISTRICT OF LONDON.

Engineering News.

OWING to the narrowness and crookedness of many of the streets and the dense congestion of traffic in the main thoroughfares, the question of transportation facilities within the city of London proper has been one of extreme difficulty and complexity. For a great many years, street railways were excluded from the main part of the city and were limited to operation in the suburban districts. In the business districts their place was taken by the cab and omnibus. Within recent years, however, the restrictions on street railways have been removed and a great development has taken place in transportation facilities in which motor omnibuses and electric railways, both surface and underground, have been the important factors. *Engineering News* recently published an article on the present condition of rapid transit service in London from which the following extracts are taken.

"The rapid development of the private motor carriage or automobile has been accompanied, in Europe, by an important development of motor omnibuses for public service, and in London there are now hundreds of these latter machines in use. The great majority of them are operated by gasoline engines, and are double-deck machines, with a spiral stairway from a large rear platform to the roof. A typical omnibus has seating accommodation for 16 inside (on longitudinal seats) and 18 outside (on transverse seats with a central gangway). The weight complete is 4¾ tons, and it is driven by a gasoline engine of 35 HP. One of the omnibus companies is operating several steam omnibuses of the Clarkson type, which were recently described at a meeting of the British Institution of Mechanical Engineers.

"In the Clarkson steam omnibus, the boiler is of a 'semi-flash' water-tube type, having a series of dished spiral coils connected together to form the equivalent of a continuous length of tube. The feed water enters at the top, and after reaching the bottom the water (or wet steam) is led to a coil directly over the fire, and then up to the final or superheating coil. The steam pressure is from 300 to 450 pounds, and the pyrometer (mounted in front of the driver) indicates a steam temperature of about 800 degrees F. The fuel is kerosene. A two-cylinder double-acting engine is used, having slide valves operated by the Joy valve gear; this drives the countershaft through a single set of spur gearing, and sprocket chains run from wheels on this shaft to sprockets on the rear driving wheels. The exhaust steam is condensed in a radiator placed in front of the machine and having vertical tubes, over which a stream of air is forced by a fan.

"The report of a Parliamentary committee appointed to investigate the conditions of vehicular traffic in London states that 520 motor omnibuses were licensed during the year 1905, and 400 of these carried 1,500,000 passengers per week. The first machine of a given class is subject to inspection before the license is issued, but the report states that the duplicate machines should be similarly inspected, while when in service the omnibuses should be frequently and severely tested, especially in regard to the steering gear and the brakes. A legal speed limit of 12 miles an hour, actively enforced by the police, is also recommended. As to the skidding or side-slip of the machines, the report states that this is mainly due to 1, a greasy or slippery road surface; 2, the mechanical action of the differential gear in propelling the driving wheels unequally under certain conditions. The liability to side-slip is greatly increased by the needlessly high camber of many roads. The danger can only be avoided by the provision of good road surfaces, kept in proper condition, and by the substitution for the differential gear of a more efficient mechanism. The chief cause of noise and vibration is said to be unevenness of the road surfaces, and some reduction would result from the use of omnibuses of smaller capacity and decreased weight. The report points out that the police have authority to order off the street any licensed motor omnibus making an undue noise, causing a nuisance by the emission of smoke, or otherwise faulty. From January 1 to June 8, vehicles were stopped 114 times for weak springs and broken frames; but the committee considered that the police should more rigorously exercise their powers to remove offending vehicles off the streets. To prevent offensive exhaust, whether due to the presence in the exhaust gases of carbon monoxide or to smoke caused by overlubrication, it is recommended that automatic ignition and automatic lubrication be included in the specifications of motor vehicles. It is also suggested that there should be a switch within the conductor's reach by which the current for ignition purposes can be interrupted, thus stopping the engine in case of emergency.

"All the street railway lines in London were operated by horses until within a few years ago, when the London County Council began to acquire many of these lines and to convert them to electric traction. At the present time there are numerous long electric lines, and the work of rebuilding the old lines and introducing electric traction is proceeding rapidly. The conduit system is adopted in the city and more crowded districts, while the trolley system is used in the outlying districts."

The London County Council now operates some 60 miles of track. The first sections were laid entirely with short yokes carrying the slot rails only, but in later work the alternate yokes are extended to carry the track rails. The tracks are of standard gauge, and are usually 9 feet centre to centre. They are laid with grooved-girder, 105 pound rails, 7 inches high, of the British standard section. Two miles of side-slot conduit line have recently been built. The tracks are laid at one side of the roadway and in the same position across Westminster Bridge. The paving is of Australian wood blocks; but on some of the conduit lines in suburban districts granite blocks are used.

The London United Electric Tramways Company has 70 miles (single-track) of electric line on the overhead trolley system. This, like all the London work, is notable for the substantial character of the construction. The tracks are of standard gauge, 9 feet centre to centre, and are laid with 6½ inch, 92 pound, grooved rails of the British standard section. These lines also are paved with Australian wood blocks. Unusually heavy steel poles are used as the span wires are 23 feet above the rails to allow of the use of double-deck cars. The equipment consists entirely of double-deck, double-truck cars. These seat 30 persons inside and 44 outside. Each car has two 40 horse power motors, the power being supplied by 500-volt direct current from the Kingston sub-station of the London Underground Railway Company whose main power station at Chelsea supplies several of the underground lines.

"Most of the London street railways use double-deck cars, both for horse and electric traction, and in most cases they are mounted on two trucks. One important line, operated by the London County Council, has cars without the usual upper deck on account of running for some distance through a shallow subway under the streets and the Erith Urban Council uses single-truck, double-deck cars. The cars can as a rule pass curves of 30 feet radius.

"The first piece of underground railway in London was opened in 1863. The original system formed an irregular belt line, with numerous connection to main line railways and with a number of surface suburban extensions. This has been in operation for many years, and consists of arched tunnel and rectangular subway (cut and cover) construction kept as near to the surface as possible. The northern portion is owned by the Metropolitan Railway and the southern portion by the Metropolitan District Railway, but it is operated as one system, the trains of each company passing over both portions. It was originally operated by steam locomotives, but these have now been superseded by electric traction.

"For many years projects were promoted for underground lines traversing the district enclosed by the original system, but none of these materialized, until a few years ago the Central London Railway was authorized to build and successfully completed an east and west diametrical line. This was a deep-level tubular tunnel line, but as a type it had been preceded by the City & South London Railway and the Waterloo & City Railway, each extending under the Thames from the central part of the city southward. Both have been succeeded by a number of other lines, several of which have been completed recently, so that there is now a network of deep level 'tube' lines, all operated by electricity. Unfortunately, the lines have not been laid out as part of a comprehensive scheme, but each one has been promoted by an independent concern with a view to a certain route or direction of traffic, so that the system is not as comprehensive or homogeneous as it might have been. Connections are made by passages, shafts, etc., at several points where the lines cross, but in many cases these involve long walks on level or inclined subways, and the climbing of spiral stairways. Elevators are used at the stations, but for some reason they are often placed at a distance from and do not reach the level of the station, so that passengers have to use a combination of elevators, stairs and passages in getting from the street to the platform. The elevators are of insufficient capacity to promptly handle the rush traffic, and streams of people then use the stairways to the surface. In several cases also, the passages are narrow, or their arrangement is awkward, so that the streams of passengers going to and from the trains are congested or 'throttled,' or even conflict with one another. Long underground passages or subways lead from the stations to important points (such as railway terminal, etc.) so that passengers can reach them without crossing the streets. At 'The Bank,' where numerous streets and lines of traffic center, there is a circular subway just below the street level, with stairways to the several streets, so that the general public as well as the railway passengers can get from point to point without crossing the streets. In the center of this subway is the entrance to the shaft of the terminal station of the Central London Railway, with connections to stations of other underground lines.

"The lines of the Metropolitan Railway and Metropolitan District Railway are at present in a transitory state, being converted from steam to electric traction, and have three systems of traction now in use on the same tracks: 1, the electric trains of the two companies; 2, suburban trains from other lines hauled by steam locomotives; 3, suburban trains from other lines which detach their steam locomotives at the connection with the 'underground,' and are hauled over the latter by electric locomotives. Eventually all the steam locomotives will be abandoned for tunnel service, except perhaps for the freight trains handled by some of the main line railways over parts of the underground lines to reach local terminals in the city. Some of the regular trains of the Metropolitan Railway consist of seven double-truck compartment cars, each of the two end cars having four motors of 200 horse power. The motor cars also have baggage compartments. The trains have the Sprague multiple-unit control system, and can be run at 45 miles an hour, the average schedule speed (including stops) being 16 miles per hour. The motor cars weigh about 38 tons each and the trail cars 10 tons each, with a total weight of 172 gross tons for the train, which is 290 feet long."

Besides the original Metropolitan lines, there are seven modern "tube" railways of greater or less importance radiating from the centre of the city and running to outlying suburbs or to the more important railway stations. These are all operated electrically.

"The ventilation is not satisfactory on any of the tube lines, the best conditions being in the large tunnels of the Great Northern and City Railway. In all the others (and even in these to some extent) headache and an oppressive feeling in the chest and head are liable to be experienced, sometimes to a very unpleasant extent. On all these lines the problem is to secure efficient ventilation without producing currents so strong as to blow passengers' hats off or severe drafts that will cause passengers to take cold. The lighting of the cars is also very unsatisfactory as a rule; in general it is dim, and in all cases subject to fluctuations which are very trying. The cars on different lines have side seats, cross seats, or a combination of both as in the cars of American rapid transit lines. In very few of them can the windows be opened, as open windows would be dangerous with the small clearance between the car and the side of the tunnel. In a few trains the cars are divided into compartments, but as a rule they are of the American type, with end doors. In some cases, side doors are also placed at the middle of the car. A unique arrangement on the City and South London Railway consists in placing a single platform between each pair of cars, giving one wide opening for passage to or from the station platform. As a rule there is only one class, but on some of the lines the trains have first-class and second-class cars. One excellent feature is the cleanliness of the cars; there is practically no expectoration in the ordinary cars, and very little in the smoking cars, the latter even having 'anti-spitting' signs. Tickets are issued to passengers, and given up to collectors as passengers leave the station platforms at their destinations. On the Central London Railway, with a uniform 4-ct. fare, the tickets are dropped into a chopping box before the passengers go to the trains."

THE EVOLUTION OF THE MOTOR BUS.

A DISCUSSION OF THE IMPROVEMENTS IN CONSTRUCTION AND OPERATION NECESSARY TO MAKE THE MOTOR OMNIBUS A COMMERCIAL SUCCESS.

W. Worby Beaumont—Society of Motor Omnibus Engineers.

As remarked in the preceding review, the motor omnibus has become an important factor in the transportation systems of European cities. In London, owing to the peculiar difficulties of surface electric traction, systems of motor omnibus transportation have probably reached their highest development and there are now about 900 of these vehicles in active use. Marked improvements have been made in construction and operation; the objectionable elements of smoky exhaust and incessant noise of operation have been eliminated to a great extent, but much further development is necessary before the motor omnibus can be called a complete commercial success. Mr. Worby Beaumont's recent paper before the Society of Motor Omnibus Engineers indicates some of the lines along which such development must take place.

Setting himself to answer the question: "What is wrong with the better types of motor omnibus?" Mr. Beaumont replies as follows:

Firstly, more attention must be given to the requirements of the motor omnibus as an intricate machine. Secondly, and to this end, more attention must be given to the requirements of the motor omnibus engineers, who have the responsibility of maintaining the omnibuses in a fit condition to be kept on the road. Thirdly, the maintenance of the motor omnibus, being placed under the superintendence and guidance of trustworthy and competent motor 'bus engineers, those engineers must be allowed to be the best judges of the requirements of their department. Fourthly, the judgment of the motor 'bus engineer, who is responsible for the maintenance of the motor 'bus in running order, must be final as to that condition, and not that of the traffic manager. Fifthly, the running of a number of motor 'buses means the maintenance of a lot of machinery.

"This last-named requirement, according to the number of motor omnibuses, means an engineering works with good equipment of tools of various kinds, and more or less in number, and workshops of proper construction and of character suitable to the kind of work which has to be done in them: there should be workshops and appliances, which must not be inferior to those of engineering works, wherein are made gas engines, petrol engines, and the highest class of millwright machinery. This may seem to be a call for a very large expenditure, but, considered with reference to a number of omnibuses, and with the imperative necessity for thoroughly good and comprehensive maintenance work, that expenditure is not only necessary, but is the means of *making*, because of saving, money.

"The present motor omnibus, of the better kinds, is a satisfactory vehicle, if those who use them could be persuaded that it is better suited for a moderate speed than for racing. The motor omnibus which, with its load, weighs 6¼ tons, running, as it often does, at 14 to 18 miles per hour, especially when running home at 1 o'clock at night on some of the lines, reminds one of an elephant bought by an ill-advised purchaser for the purpose of running in competition with an Arab steed, and one of the first necessities in development is not change in construction, except in so far as gear ratios are concerned, but in the use of the present vehicle with regard to the speed at which it is forced to run. It would be good policy, so to arrange the engine and gear of a motor omnibus, that the driver could not, under any circumstances for London use, exceed, approximately, 12 miles per hour, the gearing being also so arranged that he could, under the conditions of traffic running, maintain a high average speed, so that little time would be lost on such hills as are mostly met with in London, the power already common on these vehicles being sufficient for the purpose without going to the high powers which have been fitted to some. It may be said that a maximum speed of about 12 miles per hour is insufficient, but this would not be the case, and the statement could only be supported at the present time because so many of the omnibuses are running at high speeds, which are unnecessary, uneconomical, and suicidal. It is true that the very high speeds please some people, even on bad roads, but that which is commercially possible must be considered by the owners of things purchased for commercial purposes, and it will be much better so to work motor omnibuses now, as to enable them to be kept on the streets, than to run the risk of commercial failure, and of opposition by the many to whom they are, as at present run, a positive and real nuisance.

"The high speed, of which I have complained, is not only the cause of the troubles already referred to, but it enables the omnibuses to be run 120 miles and more per day in the 16 or 17 hours which is its day's work. There are thus only left the few hours, from 12 or 1 o'clock at night to the very early hour in the morning, at which the 'bus must leave the yard. In these few and unsatisfactory hours of the 24, all the many hundreds of parts have to be or should be, carefully looked over by competent men, so that not only is that which is obvious attended to, but so that the defect or looseness which is not obvious may be discovered. The more completely this is done the fewer will ultimately be the necessary renewals, and the less the labour in maintaining a thorough inspection. If the omnibuses run only 90 to 100 miles per day, or even less on some of the very bad roads, no more time in the garage would be obtainable, but the present heavy cost of repairs and renewals might be lessened materially. Further, it must be urged that a thorough daylight examination, and overhaul, should be carried out once every week, and every garage should be provided with a satisfactory, simple, body-lifting gear, so that the chassis may, from time to time, be made ready for a complete, unfettered overhaul. At present very few omnibus companies have sufficient stand-by vehicles; but, ultimately, it will be found necessary, considering the large number of hours per day that every 'bus runs, to have, at least, a stand-by stud of 10 per cent.

"Few who are careful in arriving at a conclusion would like to say much with regard to the oft-repeated question of steam *versus* the internal-combustion engine for motor omnibuses, though I think that few will agree with the opinion, sometimes expressed, that the internal-combustion motor is not likely to be very much improved, either in thermal or mechanical efficiency, or in its adaptability to the whole of the requirements of the motor omnibus. It is now a very few years since the present type of petrol engine was harnessed in the hard, commercial omnibus field of work, and already great improvements have been made in its adaptability to circumstances in its flexibility and quietness of running, and, in fact, in most particulars, except with regard to simplicity and accessibility. There are some exceptions, even to this, wherein automatic valves are still used, and the whole engine may be readily detached from its seating, and its pipe connections may be uncoupled and recoupled in as little time as I am taking to mention the operations. There are some engines, it is true, in which infinite pains have been taken to introduce as many moving parts and connections as could, anyhow, by any number of drawings, be conveyed to the intelligence and perseverance of those who have had to make them; but the merit of this form of ingenuity has, fortunately, not been discovered by all makers. Judging by the greater number of omnibuses in use at the present time, it is not yet understood that it is possible so to design the combination known as a chassis that the whole lot of the machinery could be taken down and reinstated by a small number of men in four or five hours, and that the gear-box and its connections may be so arranged that those responsible for the running of omnibuses would feel encouraged to make sure of the satisfactory condition of everything by the taking down and re-instating, which can be done in a couple of hours, rather than to leave things until the unsatisfactory condition is proved, either in the streets, or by finding in the garage that complete renewal is required where, by better arrangements, a mere adjustment might have sufficed.

"It is, perhaps, early to expect it, but it does appear to be desirable that the engines should be provided with a cooling system which does not need the aid of a miniature pumping station, or even of a tiny toy fan. It is also conceivable that the engine might be so made, connected, and mounted, that in five minutes all necessary disconnections could be effected, and the engine turned aside or lifted out of the chassis, for examinations and adjustments, as comfortably as the watchmaker has his watch on his table. It is, further, conceivable that it is not beyond the capability of the designer to carry the engine in the frame, and so to connect the gear-box and all the machinery, not only that the inevitable flexure of the frame may occur without twisting crank-chamber brackets off the chamber, or throwing all sorts of ambiguous stresses on the various parts of machinery and bearings, but so that flexibility in the frame may be recognised, instead of fought against, by unsuccessful attempts at complete rigidity."

ELECTRIFICATION OF THE SIMPLON TUNNEL RAILWAY.

THE USE OF THREE-PHASE ALTERNATING CURRENT IN ELECTRIC-RAILWAY OPERATION.

H. Rupp—Zeitschrift des Vereines Deutscher Ingenieure.

ANOTHER line of communication between Italy and Switzerland was opened up last year by the completion of the tunnel, twelve miles long, through the Simplon, one of those great masses that form the natural boundary between the two countries, and over whose celebrated pass so many Alpine tourists have made the journey between Brieg and Domo D'Ossola on foot or by "diligence." At the time the construction of the Simplon tunnel was begun, it was intended to employ steam locomotives, but the advances made in the art of heavy electric railroad operation during the past three years induced the engineers in charge to adopt electricity for the motive power, especially after the success attained in the operation of the Valtellina railway in Northern Italy. This line is worked by locomotives taking three-phase alternating current, and the results were, from its inception, so satisfactory that it was decided to use the same system (that designed by Ganz and Company, Budapest), for the Simplon line. An illustrated description of the line and the equipment appears in this issue, on pages 195 *et seq.* The additional data here presented are taken from the *Zeitschrift des Vereines Deutscher Ingenieure.*

The work to be done by locomotives on this line is not easy. The grades through the tunnel are steep, and an average speed of from 40 to 46 miles per hour must be maintained with trains weighing 250 tons. For supplying power, streams were available near each end of the tunnel, the river Rhone at the north end and the Diveria, a small tributary of the Tosa, at the south end. Hence, two power houses were built. That at Brieg, on the Rhone, contains two Escher, Wyss and Company turbines developing 600 horse power each at 160 revolutions per minute under 148 feet head of water. These drive the generators, built by Brown, Boveri and Company, which develop 1,200 horse power in three-phase current at 3,000 volts and 16 periods per second. At the south end of the tunnel, at Iselle, the Tosa river affords 459 feet of fall, and here two Piccard, Pictet and Company turbines are installed which run at 960 revolutions per minute and afford 750 horse power each. The generators at these two stations are designed for a 20 per cent. overload, so that their combined output is about 3,100 horse power.

The three-phase current is conducted by two overhead wires supported by span wires stretched between side poles up to the mouth of the tunnel. There are two pairs of overhead conductors in the tunnel, each wire being 0.354 inch in diameter. The wires are hung from insulators fastened to transverse steel rods at the ends of which are insulating blocks anchored to the walls of the tunnel. The use of two overhead conductors is unavoidable in the three-phase system, but each conductor being in itself of small cross section and light weight per unit of length, the maintenance of the two is a simple matter, and breakdowns are said to be very infrequent.

The locomotive carries two pairs of trolleys, one pair for operating in each direction. These are of the sliding bow type, and have a very slight effect on the wire as compared with a trolley wheel. The locomotive itself is interesting as exhibiting a type developed not only for these particular conditions, but which may become general in Europe for operating on either single or polyphase electric systems. It is mounted on three pairs of driving wheels and a two-wheel truck under each end gives the necessary flexibility to the wheel base to enable it to take curves easily. The total length of the locomotive over the buffers is 39 feet 10 inches, and its total wheel base 31 feet 10 inches. It has two motors, rated at 450 horse power each, but built for such a margin of overload capacity that the two can develop 1,900 horse power, without danger of injury. One of these motors is mounted between the first and second, and the other between the second and third, driving axles. Each is provided with a shaft, on the end of which is a crank driving the wheels by means of connecting and side rods. By this arrangement the weight of the motors is carried to best advantage, the connection between them and the driving wheels is somewhat flexible, and the two motors distribute their power uniformly to the three axles.

The cranks are made with a heavy counterbalancing segment, and the main and side rods are of I section in accordance with steam locomotive practice in both the United States and Europe. The driving wheels are 64½ inches in diameter and spaced about 8 feet apart, center to center, making the rigid wheel base quite short, 16 feet ⅞ inch. These three pairs of driving wheels carry a load of 92,400 pounds, while the total weight of the engine is 136,400 pounds. The cab is built on the frames, midway between the ends, with hoods sloping down toward the buffers, and containing the rheostats, transformers, air reservoirs, etc. Air is largely employed as an auxiliary, since the engine is equipped with Westinghouse brakes, pneumatic whistle, sanding apparatus and trolley raising device.

Since each overhead conductor is at any moment, in a distinct phase of the wave of alternating current, two trolleys must be employed, insulated from each other, and, instead of using a revolvable trolley base as is common on street cars, a separate set of current collectors is used for running in either direction. This makes a somewhat complicated arrangement of circuits and does not improve the otherwise satisfactory appearance of the locomotive. It is said to operate very well, however. The engineers of the Swiss and Italian governments imposed very rigid specifications upon the builders of these locomotives. Among other things, the motors were obliged to stand an insulation resistance test of 15,000 volts, alternating, for fifteen minutes.

The track rails are not bonded, but the six bolt angle splices are carefully fitted, and set up very tight against the head and base of the rail. The rail itself is of Goliath section, 5¾ inches high, and for each length of 32 feet 9⅝ inches, tests to a resistance of 0.000257 ohm at 32 degrees F. When the tunnel was first opened for traffic, steam locomotives weighing 103 tons, the standard on the Italian and Swiss railways, were employed. The electric locomotives that have now replaced them, have greater tractive power and weigh only 62 tons.

THE FOUR-CYLINDER LOCOMOTIVE IN GREAT BRITAIN.

TYPES OF FOUR-CYLINDER LOCOMOTIVES RECENTLY PUT IN SERVICE ON BRITISH RAILWAYS.

Chas. S. Lake—Mechanical Engineer.

THE four-cylinder locomotive has occupied an established position on European railroads for some time and, within the past few years, several railroads in the United States, notably the Baltimore and Ohio, and the Atchison, Topeka and Santa Fe, have introduced them on their lines. In Great Britain, there has been a disposition to regard the four-cylinder locomotive unfavorably, but this prejudice is gradually disappearing and several locomotives of this type have lately been placed in service on British railroads. An article by Mr. Chas. S. Lake in a recent number of the *Mechanical Engineer* describes the general features of the locomotives that have been evolved by British designers.

"Abroad if we except in some measure the United States, the 4-cylinder compound has an established position. It is accepted as the best type for working all classes of traffic, and variations between the locomotives of one country and those of another are mostly confined to the design and arrangement of essential parts, and do not embrace the main principle upon which the engines are constructed and worked. Antipathy to the 4-cylinder arrangement in Great Britain at first centred in the alleged unnecessary complication of details, then it was the compounding of the cylinders which was wrong, and finally, when the 4-cylinder simple locomotive made its appearance in a modern form, the difficulty which would be encountered in maintaining a sufficient supply of high-pressure steam was put forward and urged as a drawback to the notion.

"These and other objections have for the most part disappeared as the result of the determined efforts made on a few British railways, during quite recent years, to establish the 4-cylinder locomotive as one of the standards of mechanical engineering practice on the railways of the country. It is, of course, the duty—and also the principal object—of every locomotive superintendent to produce an engine which shall give the best results in working, having regard to economy in costs of manufacture, working, and maintenance. The cheapest type of engine to build is undoubtedly that which is most simple and straightforward in design, and if this engine will do all that is required of it, not on any specially selected occasion, but in everyday working under varying conditions of weather and load, hauling the traffic it was designed to haul, and doing the work with reasonable regard to economy in fuel consumption, then there is nothing more to be desired. The engine is in every way satisfactory, and to replace it by another, possibly of more modern construction but infinitely more costly to build and maintain, would be false policy, and quite indefensible. There is, however, a further aspect of the matter to be considered. Locomotives are not built in this country, as they are in America, on the principle of 'a short life and a hard one'; a few years of ultra strenuosity and then to the scrap heap, to make way for newer designs incorporating ideas as yet unformed when the earlier engine was built. They are constructed with the idea of many years of useful service being obtained from them before being finally broken up. The most careful and accurately fitted work is put into them, and only the highest quality materials are employed in their manufacture. This being so, it would seem to have become increasingly important, when designing locomotives for maximum duty on the main line, to adopt measures for providing the engine not only with a margin of power sufficient to enable it to cope with any chance difficulty when traffic is, either expectedly or unexpectedly, heavier than usual, but also to provide a reserve of capability for meeting future needs when, if the present rate of evolution is maintained, heavier train loads and more severe traffic conditions generally will have become the rule. . . . .

"Apart from the question of working principle, there have to be decided such matters as cylinder disposition and wheel arrangement, and in four-cylinder locomotives these are of added importance, for they influence to a very great extent the whole design. Some engineers prefer to divide the cylinders and valve gears, arranging them for driving different axles, whilst others adopt the method of placing all four cylinders in line below the smokebox generally, although by no means always, for driving the same axle. The latter plan, so far as it relates to the cylinders, has the advantage in compound locomotives of shortening the steam passages between the high-pressure and low-pressure cylinders, and whether in compound or non-compound engines it allows of a simplified arrangement of the valve gearing in which only two sets of gear are employed for working the four steam distributing valves.

"Within the as yet restricted limitations of British practice in designing four-cylinder locomotives there are to be found examples of both cylinder and valve gear arrangements, and latterly the divided cylinder method has been introduced in conjunction with the plan of only two sets of gear for the four cylinders.

"This is on the Great Western Railway. The engine is of the Atlantic, 4-4-2, type, with four simple cylinders, of which the inside pair are carried forward of the smokebox and drive the crank axle of the leading coupled wheels, whilst the outside cylinders are located at the rear of the bogie centre, in which position they drive the second pair of coupled wheels.

"They are not placed altogether behind the bogie, as in the de Glehn compounds and other engines, but centrally with the rear bogie wheels, with their steam chests above them. The valve gearing is of the Walschaert type, and the valve of the inside cylinder only is connected directly to the gear, the outside valve being operated through a cross lever having a crosshead connection on the inside and a jointed connection to the outside valve stem. The inside valve receives motion in the ordinary manner from its rear end, but the outside valve is reciprocated from the forward end where, as before remarked, the spindle connects with the cross lever from the inside motion. This is the first instance in this country of a 4-cylinder locomotive having divided cylinders and only two valve mechanisms for the four valves.

"The plan of setting the cylinders to drive different axles has the advantage of distributing the working stresses over two axles instead of concentrating them in one, and if this can be successfully accomplished whilst evading the necessity of employing four valve gears it would be worthy of close attention. On the Great Northern Railway there are two four-cylinder compound locomotives and one non-compound at work, and one of the compounds as well as the simple engine has its cylinders arranged in line below the smokebox. Beyond this fact, however, the two locomotives are wholly dissimilar. The compound drives on two axles, but the four connecting rods of the simple engine all drive the leading coupled wheels.

"This latter engine began its career with two sets of Stephenson link motion only, but it has now been running for some time with independent gear for each cylinder, viz., Walschaert's for the outside and link motion for the inside cylinders. The same arrangement is applied to the Doncaster-built compound, but the other 4-cylinder compound on the same railway, built by the Vulcan Foundry Company, has divided cylinders and valve gears as adopted by de

Glehn and other engineers to meet the same conditions.

"The latest express passenger locomotives designed by the chief mechanical engineer of the North-eastern Railway have four cylinders in line and only two sets of gear, and this is proving very satisfactory. On the other hand, it is certain that the London and North-western Railway has greatly improved the Webb system 4-cylinder compound express locomotives by replacing the original 2-gear arrangement by a separate set of gear for each cylinder. These seemingly conflicting results are explained partly by the difference existing between the actual design and methods of applying the gear, which methods vary considerably, and being directly associated with the distribution of steam to the cylinders, play an all-important part in the general efficiency of the locomotive. There is no justification at the present for saying that any one combination of cylinder and valve-gear arrangements possesses substantial advantages over others.

"Those who have much occasion to travel on the railways of this country for the purpose of noting the work performed by locomotives, and especially those whose duties or privilege give them access to the footplate under actual running conditions, can hardly have failed to come to the conclusion that the time has now arrived when the four-cylinder engine ought to be given a thorough and impartial trial, and present indications are in favor of the assumption that this will be done. Even then, however, it is obvious that only a new phase of the simple *versus* compound controversy will have been entered upon, as British engineers, or the majority of them, appear to be still unconvinced of the merits of the latter in spite of all that has been and is being done abroad."

TRANSPORTATION EXHIBITS AT THE MILAN EXPOSITION.

TYPES OF ELECTRIC LOCOMOTIVES AND APPLIANCES WHICH SHOW THE TREND OF EUROPEAN DESIGN.

A. Zweiling—Zeitschrift des Vereines Deutscher Ingenieure.

AT the Milan International Exposition of 1906, a number of exhibits of both steam and electric locomotives were shown which were very complete, and "up to date," as representing current European practice for both steam and electric roads. Reference has been made in former issues of this magazine, to the development of steam locomotive design in Europe, and it has been pointed out that the locomotives shown at Milan last year were almost without exception compounds, mainly of the four-cylinder type. The majority were fitted with superheaters and they showed in these two details of design, the most advanced ideas thus far put into practice. The electric railway exhibits at Milan were described by Herr Zweiling in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure.*

As in the United States, no one particular system of either direct or alternating current has been found in Europe to be the best for all conditions. Consequently, there were shown at the Exposition, motors for direct, for single-phase alternating and for three-phase alternating current, together with the controlling apparatus and brake systems now in use on heavy cars and locomotives. In Italy, there is a line from Milan to Porto Ceresio, 81 miles long, operated by large, double-truck cars. These motor cars seat about 42 passengers, and their appearance closely resembles cars used for the same kind of service in the United States. One of these cars was shown at Milan. It is mounted on two four-wheel trucks, each truck fitted with two 160 horse power, 600 volt, direct-current motors. The cars now in use have been equipped partly with General Electric, and partly with Thomson-Houston motors, and they are designed for a maximum speed of 56 miles per hour, and a normal speed of 37 miles per hour. The cars are fitted with shoes for collecting current from a third rail. Another, but smaller motor car was shown for a Hungarian road, also equipped with direct-current motors. These two are fairly representative of direct-current motorcar practice in Europe at the present time.

Where alternating current is adopted, the requirements to be met have led to the development of a locomotive peculiar to Europe. One of the three-phase, 3,000 volt, alternating-current locomotives built for the Valtellina railway was shown at Milan. This is almost a duplicate of those built for the Simplon Tunnel railway which are described in a review in this number. They are equipped with alternating-current motors, taking current at 3,000 volts, and are built with cranks on the motor shafts which operate the driving wheels through connecting and side rods. They can develop about 1,900 horse power at slow speed, and are designed to haul trains of 250 tons weight, on a level, at 47 miles per hour.

Another three-phase locomotive exhibited was that built by the Siemens and Halske Company for the Berlin-Zossen high speed tests, and built to work on three-phase current at 10,000 volts, transforming, of course, to a lower voltage at the motors. It has been pointed out that the economy attained by the use of such high-tension current is largely offset by the enormous weight of the transformers which must be installed on a 1,000 horse power car. As showing, however, what can be done in the direction of high speed with very light trains, such systems are well worthy of careful, detailed study.

Single-phase alternating-current motor cars were also well represented. One of these cars, that in use on the Vienna-Baden interurban line, is a double-truck car, driven by compensated single-phase alternating-current motors for the purpose of making it interchangeable with the Vienna city tramway cars operating on direct current. Another single-phase car shown was for the Blankenese-Ohlsdorf suburban line in Prussia. This car does not present any unusual features, but is much larger and has more powerful motors than the Vienna-Baden car. While conclusions based on general principles are apt to be erroneous, it nevertheless seems that the three-phase alternating system is becoming the system most favored by European engineers. Aside from the small amount of copper required for the transmission of a given quantity of energy, the motor possesses the advantage that in running down grade, or coasting, it acts as a generator, and feeds current into the line.

Among the novel features of the Exposition were a passenger motor bus and a freight carrying wagon or dray, driven by electric motors. These are steered by hand, but draw their energy from an overhead wire through a long, flexible pole. These vehicles have been called "trackless trolleys," and for operation along highways and city streets, seem to possess some merit. Both are equipped with direct-current motors. A convenient adjunct to an electric railway shown at the exposition is a tower wagon for making repairs to overhead wires. It has an extension ladder, with a platform at the top large enough for two men to stand while making repairs and to hold the necessary tools. It can be moved from place to place at any time, being fitted with a standard Daimler 20 horse power gasoline motor, thus giving ease and rapidity of motion and transference to any place on the line to be repaired.

Cars were exhibited with revolving snow sweepers, similar in general features, but smaller than those in use in American cities. A flanger car, pulled by a regular motor car, was a rather new departure, as the flangers were attached to a car separate from the snow sweeper car. Air brakes for electric cars and locomotives were also on exhibition, and for these the motor compressors employed are very similar to the American types of such devices. For track work, such as drilling holes for rail bonds, cleaning rail ends by sand blast before welding, and similar work, a set of portabe machine tools was shown, all supplied with power from a movable power plant. Two of these plants were exhibited; one had a 50 horse power gasoline engine driving a dynamo which supplied current to the motor-driven machine tools referred to; the other had a boiler and steam engine driving the dynamo. For machine shops there was exhibited an air compressor, motor driven, mounted on a three-wheeled truck, which could be dragged about anywhere in the shop. The motor is connected to the nearest outlet on the power circuit of the shop, and a hose attached to the reservoir supplied by the compressor, feeds pneumatic tools at any point.

ELECTROLYTIC CORROSION OF IRON AND STEEL IN CONCRETE.

RESULTS OF EXPERIMENTS TO DETERMINE THE AMOUNT OF CURRENT AND THE TIME NECESSARY TO PRODUCE CORROSION IN METALS IMBEDDED IN CONCRETE.

A. A. Knudson—American Institute of Electrical Engineers.

IT has long been known that cement or concrete will effectively protect steel structures against the corrosive and rusting action of both salt and fresh water, but its effectiveness as an insulator against stray earth currents has always been in doubt. The question is one of very great importance and Mr. A. A. Knudson's recent paper before the American Institute of Electrical Engineers presents some very valuable data as to the time and current necessary to produce corrosion of iron imbedded in concrete, by electrolytic action.

Mr. Knudson began his experiments in March, 1903. Blocks of concrete, consisting of equal parts of Portland cement and sand, were made in ordinary metal pails slightly larger at the top than at the bottom. In the centre of each block was placed a 2-inch wrought iron pipe which was buried in the concrete to a depth of about 8 inches. The blocks when finished were 12½ inches high, 10 inches in diameter at the top and 8 inches in diameter at the bottom. During the tests the blocks were immersed in water to a depth of about 10 inches and were supported on wooden blocks. A binding post was attached to the projecting end of the pipe; the current, after passing through the block was led off through a 5 inch by 6 inch plate immersed in the water.

In the first series of tests, three blocks were used. One, for the purpose of comparison, was immersed in sea water without any current being passed through it. The others, one of which was immersed in salt and the other in fresh water, were connected in series and a current of 0.1 ampere was kept continuously flowing through them.

"At the conclusion of this test which extended over thirty days' time, the blocks were removed, and after allowing them to dry they were broken open. It was found to be quite easy to break open the blocks through which the current had passed as they had already become cracked. The block which had not been subjected to electrolysis was broken with the greatest difficulty. The former showed on their interior strong evidences of electrolytic action in the form of what was apparently a deposit of iron rust extending from the pipe toward the outside of the block. Along certain lines which acted like lines of cleavage, the cement was found to be softened so that it could readily be cut or scraped with a knife. This softening was such that the point of the blade of a pocket knife could be inserted into it far enough so that the knife was supported in an upright position. The pipes enclosed in these blocks were found to be considerably corroded. A portion of the scale on the corroded parts of these pipes was removed and the pipes were weighed. The pipe in the first-mentioned block was as bright as a new pipe and the concrete showed no evidences of a deposit of iron rust. Weighing of the pipes had been made before casting them in the blocks. Weighings made at the conclusion of the experiment showed losses in the pipes which had been subjected to electrolytic action amounting to 1.55 ounces in the case of the block immersed in fresh water and 1.1 ounces in that immersed in salt water.

"The results of these experiments seemed so important that it was thought best before drawing conclusions to have the tests repeated, and therefore another set of experiments similar to the first, was made to see how the data would compare." This second series of tests was carried out on exactly the same lines as the first except that a different brand of cement was used and the results obtained were very similar and, if anything, more pronounced.

"These tests and experiments go to show that only a small fraction of an ampere is necessary to cause electrolytic action. The element of time being always with us, it is only necessary where electric currents are present of sufficient voltage in the proper direction, to cause even a very small amount of current to pass that will in time cause corrosion upon interior steel structures, whether placed in concrete, brick, or in granite masonry. It is not expected, however, that large granite piers would develop cracks, but electrolysis to interior steel work and to bridge anchorages may go on just the same. Cracks may develop, however, in concrete piers of small bridges, such as those which cross creeks or canals.

"By way of a practical illustration, there is a bridge in this city (New York) of this description over the Gowanus Canal, South Brooklyn, at Hamilton Avenue. A portion of the Bridge Commissioner's report ending June 30, 1906, referring to this bridge, is as follows:

"'Since construction the foundation walls of this bridge have developed some rather serious cracks, occurring on both sides of the canal, and there has been a movement of the walls towards the centre of the canal. During the last three months this movement has amounted to half an inch. Previously the movement totalled about three and one-half inches. From October to March there was practically no movement. A continuation of this movement for several inches more will result in the necessity of alterations in the centre of the leaves, as they will interfere before the bridge can be fully closed.'

"With a view of ascertaining the electrical conditions, we have made a few tests at this bridge. The voltmeter readings show the steel structure to be positive to the canal, positive to water-mains in the street, and positive to the trolley-rails on the bridge, ranging from 0.5 to 1.5 volts. These readings were taken when the car-traffic was light. Some of the cracks on the concrete had been plastered over, but others were quite visible. The tests indicate that the trolley tracks on the bridge are in connection with the steel structure. Tests were also made on another bridge of the same construction a little further north over the same canal, at Ninth Street. The readings here were exactly the reverse ot those found at the Hamilton Avenue Bridge, the structure being negative to canal, to water-mains and tracks. There were no visible cracks in the concrete of either foundation. Although, the cracks in the concrete of the Hamilton Avenue Bridge are attributed to other causes in the Commissioner's report, we believe these tests and observations point strongly to electrolytic action from trolley currents as being the true cause. This seems to us the more reasonable cause for these cracks, in view of the results of our laboratory experiments just described. Ordinary care would suggest that costly structures of this kind in this or other cities should be periodically inspected for evidence of electrolytic action upon the interior steel work, especially if located contiguous to water, or in the vicinity of electric railways or *railway power stations* as in the case just cited. Furthermore, this question should be carefully considered when such structures are planned, tests made at locations of proposed bridges or other structures, to ascertain the electrical conditions and the possibilities of injury due to electrolysis from stray currents.

"This question of electrolytic corrosion of interior steel in the construction of high buildings, however, has not been entirely neglected. There is at least one case, that of the *New York Times* Building, where provision has been made in advance as a protection. In the Building Supplement, issued by that paper, dated January 1st, 1905, an interesting description is given in detail of the entire construction of that building. The following extract, referring to electrolysis, will be of interest:

"'The danger that in the case of the steel frame, rust and the disintegration of electrolysis would hasten the process of dissolution so much as to make structures of this kind prematurely unsafe through the destruction of their supports, was recognized in time to permit of ample safeguarding in the case of the steel frame of the Times Building. It is axiomatic that columns to which moisture has no access will not be impaired by rusting, and that those effectually insulated from vagrant electrical currents will not be affected by electrolysis. The first consideration was to keep the basements dry. Hence the thorough waterproofing and draining of the retaining walls already described, which was carried under the floor of the press room, occupying the great area of the sub-basement. As a further safeguard, all the steel members up to the street level are incased in Portland cement mortar, to the minimum thickness of three-fourths of an inch.

This is effectual protection against rust deterioration. Under these conditions electrolytic disintegration is deemed impossible, but the probability of its occurrence in even microscopic degree is rendered still further remote by as perfect insulation as can be provided. There is sufficient grounding to relieve any electrical tension which may exist in any part of the steel frame by drawing off the current at points where electrolytic action cannot be set up.'

"This is the first instance we have noticed where a large corporation has recognized this danger and has taken steps beforehand to avoid it. The protection of steel structures already constructed, however, is a different matter. While plans may be made to provide insulating methods and water-proofings before construction, it is not easy to prevent corrosive action, when the conditions are favorable, after construction.

"From these laboratory experiments, as well as observations in practice, we draw the following conclusions:

1. Steel structures are well preserved from ordinary corrosion by concrete if placed either in salt or fresh water.

2. If but a small fraction of an ampere of electricity passes from an interior metallic column or structure into concrete or masonry as usually made, there will be corrosion of the metal and disintegration of the concrete or masonry.

3. Structures of steel in concrete that are subject to sea water are in more danger from electrolytic action than those in fresh water, by reason of the lower resistance of concrete in sea water as shown by the laboratory experiments.

4. In no sense can concrete be considered an insulator, and as shown it is from all appearances, just as good an electrolyte as any of the soils found in the earth."

REINFORCED-CONCRETE HIGHWAY BRIDGES IN GERMANY.

EXAMPLES OF RECENT DESIGNS OF ARCH BRIDGES FOR GERMAN HIGHWAYS.

Neuffer and Schnidtmann—Deutsche Bauzeitung.

IN Germany, as elsewhere, the advantages of reinforced concrete for a great variety of purposes are appealing to engineers. In public works and for many purposes in railroad operation, the use of this material is steadily increasing. While hand mixing is still generally practised, machine mixers are being introduced and are coming more and more into favor. Recent issues of *Deutsche Bauzeitung* have contained descriptions of some notable examples of structures built of concrete, and of these, two bridges, lately completed, are of considerable interest not only on account of the material of their construction, but for their generally substantial appearance and graceful design.

One of these is an arch bridge carrying a highway over a double track railway line near Otting. The railway is in a deep cutting at the point where the road crosses it, and the bridge abutments are placed well up on the banks on either side. Thus, from the track to the under side of the bridge there is a clear height of 41 feet, but the abutment piers being set high up on the slopes, the actual height above the base line of the arch at its center is 20 feet 4 inches. The bridge is of 78 feet 9 inches span, and its total length on the roadway is 161 feet. The roadway is 14 feet 9 inches wide, and is protected at its outer edges by iron hand rails set in concrete posts.

The strengthening of the floor system is effected by means of longitudinal plates between which transverse rods or bars are set, and in the rectangular spaces so formed diagonal rods give the necessary reinforcement to the concrete structure. The members of the arch itself are strengthened by iron rods run through them longitudinally, the outer rods, or those forming the corners of the rectangular section of the arch members, being tied together by diagonal flat ties. The bridge is very rigid, and sufficiently heavy to give a very substantial appearance. The general design is that of an arch with vertical posts resting on it and supporting the roadway above.

The other bridge is much larger and carries a street across a number of railroad tracks in the city of Ulm on the Danube. It is a very wide arch, of 187 feet span, and carries a roadway and sidewalks protected by parapet walls. The entire width including sidewalks is 33 feet, and the general design resembles that of the ordinary type of structure executed in stone. The design is very simple, the arch being 187 feet wide and 19 feet high above the spring line. The abutments of the bridge are built of stone, faced with Portland cement, so that the whole exterior of the structure is of uniform appearance. The bridge is so large that a good deal of new work had to be done without interfering with railway traffic underneath, and a large amount of timbering had to be used in the construction of the forms while the work was in progress. For mixing the concrete, both hand and machine mixing were employed, and the proportions of cement, sand and crushed stone varied from 1, 2¼, 6¾ to 1, 2½, 5. The total cost is stated to be $39,675, which for a total of 5,938.3 cubic yards, makes the average cost per cubic yard about $6.70.

THE NEW BREAK IN THE COLORADO RIVER.

A DESCRIPTION OF THE OCCURRENCE OF THE BREAK AND THE MEANS EMPLOYED FOR CLOSING IT.

H. T. Cory—Engineering Record.

A REVIEW in the February number of THE ENGINEERING MAGAZINE outlined the history of the diversion of the Colorado River into the Salton Sea and described the attempts that had been made to return it to its original course. Six attempts were made to close the break in the river bank and finally, after a struggle extending over a period of two years, the Colorado was forced back into its original bed and again flowed down to the Gulf of California. Scarcely a month had passed, however, before a sudden flood made a new break in the bank and within a few hours the greater part of the river's flow was again on its way to Salton Sea. The story of the closing of this latest break is told by Mr. H. T. Cory in a recent number of the *Engineering Record.*

"On Nov. 4, 1906, the break in the Colorado River through which all of its flow had been running to the Salton Sea was technically closed, meaning thereby that the rock-fill dam which was thrown across the break was raised at all points above the water surface. Of course quite a little leakage through the dam was taking place and this was checked by unloading gravel and clay over the dam and by pumping a banquette on the upstream side with a suction dredge. On Nov. 15, all of this seepage water was cut off and the dam raised as rapidly as possible with clay and gravel, mixed in about equal portions, that it might be high enough to be safe against the highest water which might be expected in the Colorado River. Work was in progress along the levees connecting the north end of the dam with the reinforced concrete and steel headgate, about 3¼ miles above, which is founded on a rocky point which juts out to within about 1,700 ft. of the west bank of the Colorado River; and from the south end of the dam along the west bank of the Colorado River for a distance of 8 miles.

"A sudden flood due to a rainfall extending over the watersheds of the Gila, Salt and Verde Rivers, reached Yuma late in the afternoon of Dec. 7 and four hours later the water began to rise very rapidly at the Lower Heading, as the location of the break is generally called. The water rose very rapidly, as is usual with such floods, and the height of the water in front of the dam, which had gradually fallen from El. 113 ft. above sea level on Nov. 4 to El. 110 ft. on Dec. 7, reached El. 116.4 by 5 o'clock the following morning. In many places the water began to 'blow up' back of the levees in the vicinity of the dam, and a large force of men which was at work finishing the dam and had been called out in anticipation of trouble, found it necessary to distribute its efforts over about a mile of levee and dam. Three 'blow ups' very close together about 2,500 ft. south of the end of the dam seemed no more dangerous than many others and were apparently checked at 12:30 A. M., Dec. 8. About three o'clock, however, they again broke forth suddenly and more dangerously than before and soon filled the borrow pits which were on the land side and ran off over the ground in a westerly direction following the slope of the land, which is away from the river bank. Shortly after, the ridges in the borrow pit, which were but little above the original land surface, were overtopped and the water ran for a time in both directions, but the fall of the land being toward the dam into the channel of the old break at the end of the dam, in a very short time the entire flow through the break was in that direction. The soil erodes almost like sugar, and by 5:30 A. M. it was evident that unless the river should fall before the cutting back should reach the old break on the river side of the levees, nothing could prevent a repetition of the original break. The river did fall rapidly, but not sufficiently to prevent the catastrophe, and by noon of the next day the greater portion of the Colorado River was again on its way to Salton Sea.

"The water rapidly cut away a bend which in turn caused a rebound of the water which cut away the back of the levee, and then continued along the levee in the borrow pit to the end of the dam, eroding the downstream slope of both levee and dam. In about eight hours the cutting action on the downstream toe had worn away so much of the levee that it failed at a point near the south end of the dam, and because of the greater depth there the water cut back through this new break more rapidly than elsewhere.

The new break formed a very tortuous channel and the cutting on the outside of the various curves eroded away material with marvelous rapidity. The force of the current coming over the broad shallow reach exactly opposite the dam gathered together in a very narrow and swift current, cutting away the little strip of original soil lying between the break and the levee just south of the dam, and it was soon evident that heroic efforts would be necessary to prevent cutting through the dam itself at its south end. Gravel and rock were dumped at this point as a blanket to protect against such erosion and the efforts were successful.

"In view of the experience in closing the break by means of a rock-fill dam there was little doubt but that closing the new break was a matter of money and equipment very largely, with the difficulty that at this season of the year sudden floods are very apt to occur in the Colorado which would make the task far less certain of a satisfactory result. The real trouble, however, was seen to be not the closing of the break, but the making of a levee system along the Colorado River bank which would be unquestionably safe. The very large expenditure which was seen to be necessary was felt to be too great to be borne by the financial interests which had closed the former break and the matter was brought to the attention of the United States and Mexican Governments.

"On Dec. 20, instructions were received to begin work closing the break, plans for which had been thoroughly matured in the meantime. Material was rushed forward and two lines of trestle started across the new break. These trestles were intended to be 50 feet apart, center to center, and each consisted of four pile bents 15 feet center to center, with two 8-inch by 17-inch stringers as decking. The lower trestle was pushed to the exclusion of the second or upper trestle because it was deemed possible that material could not be gotten on the ground fast enough to drive the two simultaneously.

"The lower trestle was practically completed and rock would have been dumped therefrom on Jan. 1 but for two sources of delay. The first of these was lack of piling which delayed the work about 48 hours and the next was two days and a night of cold drizzling rain which found the camp unfinished to such an extent that the men were thoroughly wet and chilled and so very uncomfortable that they flatly refused to work in the rain on the second day. In consequence another flood from the Gila, the Salt and the Verde River basins came up before any rock could be dumped from this trestle and fifteen bents at its north end were washed away together with about 250 feet of the end of the levee. When this flood went down work was immediately begun repairing this damage, and again a flood came, tearing away several bents in the center and thus changing the channel to the center of the trestle. The water here was about 35 ft. deep, and the current was very swift and struck the trestle at an angle of about 40 degrees. The Colorado River in times of flood carries an immense amount of drift and this circumstance contributed to make the task of driving the piling in the break of the trestle one of exceedingly great difficulty. Nevertheless the trestle was again finished practically when another flood occurred, coming from the same watersheds and carried away several more bents. It soon passed and these were repaired as soon as possible, 90-foot piling being used, the cut-off being 10 feet above the water surface. Finally on Jan. 27, at 4 o'clock in the afternoon, the first trainload of rock was pushed out upon this patched-up trestle and within 48 hours about 12,000 cubic yards of rock were unloaded therefrom into the bed of the river. On Feb. 2, another rise occurred in the river, but sufficient rock had been gotten into place to hold the first trestle and give a difference in head above and below it of 4.4 feet, so that but twelve piles were washed away from the second trestle, although it had not been possible to entirely finish it and dump any rock from it. The drift piled up against both trestles to an alarming extent, but although it pushed both trestles out of line pretty badly in a couple of places they were not very seriously damaged. Repair work was started on the upper trestle the moment the water in the river started to go down and although the difficulty of driving very long piling in 35 feet of water with a swift current and through a mass of accumulated drift was very great, the second trestle was completed on Feb. 4 and the dumping of rock and gravel from it started at 4 o'clock in the afternoon. On Feb. 4 the discharge in the Colorado River had dropped to about 25,000 second-feet and sufficient material had been dumped from the upper trestle to insure its being made safe against a reasonable flood within the time in which one can reach the Lower Heading from the watersheds which alone can produce such a rise in the river.

"At the present writing there are now working on the reconstruction and extension of the levees and closing the break the following force of men, horses and equipment: 1,220 head of stock, 375 Indians, 400 Mexicans, 500 white men, 4 steam shovels, 1 steamboat, suction dredges, 7 locomotives, not including those hauling rock on main line. In addition there are 200 steel side-dump cars of 45 cubic yards capacity and 450 flat cars in this service exclusively, and the equipment trains and men working in the various outside quarries. Four top and two floating pile drivers had been in use until the completion of the trestle. The total volume of earth to be moved in the levees is 880,000 cubic yards. The total volume of rock which will probably be required to complete the dam proper is something in the vicinity of 100,000 cubic yards, and there will be some 75,000 cubic yards of clay and gravel.

"In the fourteen days' work on closing this last break there were put in place 2,202 carloads of material, aggregating about 52,000 cubic yards of rock, 5,000 cubic yards of clay and about 20,000 cubic yards of gravel. The total length of the trestle is 1,125 feet and the water was allowed to pour over 680 feet of this. The maximum amount of water that ever went over the dam was about 35,000 second feet. The overflow was not uniformly distributed over the entire length of the dam so that in places for several hours there was undoubtedly as much as 100 cubic feet per second per linear foot going over the dam.

"There are three possible, almost probable, sources of failure which may overtake the present work. The first is the possibility that a rock-fill dam cannot be built in a silt formation, which erodes almost as easily as sugar, without any foundation whatever. This is exactly what is being attempted and in the light of experience here it is not believed there will be much trouble from this source. The second is that both trestles are patched-up weak affairs with bents badly spaced and piles out of line and out of plumb. In many cases the alignment was changed and forced downstream in order to utilize to the utmost such portion of the bents which were damaged but not entirely taken away, as was at all safe, in order to begin unloading rock at the earliest possible moment. The third source of possible failure is the possibility of a very great flood coming down the Colorado River and entirely overtopping the trestles or the dam to be, before the dam itself is raised to its final height. The top of the dam will be at El. 124 ft. This is believed to be at least 4 ft. above the highest high-water mark which will ever occur in the Colorado River."

THE HIDDEN COALFIELDS OF THE MIDLANDS.

THE UNDEVELOPED COAL RESOURCES OF ENGLAND WHICH LIE BENEATH THE RED TRIASSIC ROCKS OF THE MIDLAND COUNTIES.

Prof. C. Lapworth—The Mining Journal.

THE gradual exhaustion of the world's coal resources has been viewed with apprehension for a great many years and its threatened menace to industrial greatness has led all manufacturing countries to make extensive and systematic search for new coal areas from which supplies might be drawn after the existing workings are exhausted. Nowhere has the search been prosecuted with greater activity than in England and the successful demonstration of the continuity of the coal deposits now worked, beneath the red Triassic rocks of the Midland counties is one of the triumphs of applied geology. A recent number of the *Mining Journal* contains an abstract of a paper by Prof. Lapworth which describes the occurrence and extent of the hidden coalfields of the Midland counties of England.

"The day was when it was thought that each of our visible coalfields in the Midlands was a single and complete basin in itself, whose coal seams and associated strata had no relation to those of the other visible coalfields of the region. But that primitive opinion has long since been disproved by the advance of geology, and the view now generally accepted among those who have even a passing acquaintance with the science is that all our visible coalfields are merely the exposed coal-bearing portions of what once was a continuous sheet of Carboniferous strata, originally laid down in one and the same grand area of deposition, and afterwards covered up by a similarly continuous sheet of red Triassic rocks. These two rock sheets, the dark Carboniferous below and the red Triassic sheet above, became bent and folded by earth crust movement into broad arches and troughs. From the crests of these arches the Triassic rocks have been swept off by denudation, laying bare the coal measures below. These bared portions now form our visible coalfields.

"But in the broad troughs and depressions between these arches the red rocks of the Triassic sheet still remain intact, while beneath that sheet, at depths which increase, broadly speaking, as we pass outwards from the visible coalfields towards the central parts of the depressions, the coal measure sheet is preserved, and forms an enormous hidden coalfield or coalfields underlying all the country intervening between one visible coalfield and another.

"But while this view is adequate enough as a working generalisation, it is insufficient if we descend to details, for it takes no account of the minor complications which enter into the matter. The coal measures sheet is by no means uniform everywhere, either in character or thickness; for in the northern parts of the Midlands, as in Lancashire and North Staffordshire, the coal measures are a mile in depth, and their middle member is exceedingly rich in workable coal seams, while towards the south the sheet becomes much thinner; finally, all that remains is a mass of sandstones and shales from which coal seams are absent, or, if present, are thin and insignificant.

"The Midland mining community has been by no means slow to follow up the results of geological discovery and speculation, and to extend its mining enterprises well outside the limits of the visible coalfields into the hidden coalfields beyond. The late Mr. Henry Johnson might almost be called the British pioneer in this respect, and his conquest of the hidden coalfield of Sandwell in 1873 was as bold and startling at the time as it was successful in its results. In South Staffordshire alone the total area of hidden coalfields below the red ground already practically proved by workings, shafts, or borings in the Cannock Chase country to the north, the Sandwell-Hampstead-Langley ground to the east, the Baggerdige-Four Ashes country to the west, may be roughly set down as almost equal to one-third of the total extent of the visible coalfield itself.

"During the last fifty years the mining community of Leicestershire and East Warwickshire have doubled the previously known extent of their coal mining country by opening out the hidden coal measures below the red ground; and the hidden coalfields claimed by mining authorities as already proved below the red ground to the east of the Yorkshire-Nottinghamshire coalfield amounts to more than 500 square miles; indeed, much of this is now being worked from shafts far distant from the visible coalfields.

"But if geologists are right in the conclusions which they draw from the facts won by their researches, the total area of hidden Midland coalfields hitherto entered upon, or even fairly proved by shafts or borings, is but a fraction of that which actually exists. As the output of coal increases, and our visible coalfields begin to show signs of exhaustion, the questions become more pressing year by year: Where do these hidden coalfields occur? and which among them are so situated and so prolific in coal seams that they offer the greatest promise of commercial exploitation and profit?

"The hidden coalfields lie buried under the Triassic cover which overspreads the intermediate basins. Where the elevations slope down very gently into the basins, as in Warwickshire and East Nottinghamshire, the prolongation of the coal seams under the red ground can be followed stage by stage outwards from the visible coalfield itself. This can be done in three ways:—

(1) By working the coal seams foot by foot from the collieries inside the visible coalfield deeper and deeper under the red ground.

(2) By sinking trial borings in the red ground in advance of the workings, and proving the existence of coal measures preparatory to sinking a shaft; or,

(3) By boldly sinking a shaft in the red ground into the hidden coal measures below.

"By these three methods, employed either singly or in combination, large areas of coal-bearing ground have been won, as we have said, from the collective area of the hidden coalfields of the Midlands during the last fifty years, and have been added as proved marginal coalfields to the edges of the visible coalfields of former days.

"The total area of hidden Midland coalfield already proved is about 830 square miles, equal to about one-half the area of the visible coalfields. But this proved ground is a mere fraction of the collective area occupied by the hidden coalfields of the Midlands. While it is as yet impossible, and will be for many years to come, to calculate with any approach to accuracy the exact extent, yet if we make a rough estimate, founded upon the assumption that the profitable coal measures are continued under the red rocks from those points where we find them sinking down under the red ground at the edge of one visible coalfield to the point where we find them emerging again at the edge of another, we may perhaps set down the area of hidden coalfield yet to be tested at some 5,000 to 6,000 square miles.

"But this amount must be largely discounted; for, both from the mining and commercial points of view, there comes eventually a downward limit beyond which it becomes unprofitable to follow these hidden coalfields in their underground extension below the Trias, no matter how promising the geologist may consider them to be as respects the number and quality of the coal seams they may possibly contain.

"In the Florence collieries of North Staffordshire coal is profitably worked to a depth of 3,000 ft., and in the colliery of Pendleton, in Lancashire, to a depth of 3,483 ft. It is not unlikely that the time is fast approaching when such mines will be worked practically to a depth of 4,000 ft., but this may be said to be the downward limit of profitable working as accepted by the mining engineers of the present day. This depth was adopted as the limit by the Commissioners in the Royal Coal Commissions, and we cannot do better than follow their lead in this respect, and set down the limit of possible profitable coal working at a depth of 4,000 ft.

"But this downward limit has a most important bearing upon the matter of the unproved hidden coalfields of the Midlands, and at once removes at least half the area they probably occupy from the category of practical politics. If the Triassic rocks and the underlying non-profitable coal measures of the Midlands retain the same thickness in the cores of the great basins as they possess along their margins, the productive coal measures in the central parts of most of these basins must be below this limiting depth of 4,000 ft. . . . . .

"Judging from the report of the Coal Commission, only some 800 square miles or thereabouts of the hidden coal-bearing country of the Midlands has hitherto been tested by coal workings or by borings, and all the rest has yet to be proved. Throughout much of this remainder the coal must lie at greater depths than 4,000 ft. But if the conclusions of the geologists who aided in drawing up these reports are well founded, more than 3,000 square miles of hidden coalfield lie as yet untested at less than 4,000 ft. from the surface.

"It cannot reasonably be hoped that very much of this untested ground will be entered upon for many years to come, and in estimating the promise it holds out we must not forget that with every increase of depth the working becomes more difficult and more costly. We cannot safely presume that from all the hidden coalfields yet to be tested the miner can expect to secure an available mineral wealth per square mile proportionate to that of the coalfields already proved.

"It is well to be assured that in all likelihood the collective area of unproved hidden coalfields of the Midlands, in which coal lies within a possible working depth from the surface, is larger than the collective area of the visible and proved coalfields combined. But it will be a great misfortune if this assurance prompts to hasty experiment or rash speculation. The complications are so many that we cannot be too cautious. Our geological researchers must be taught to carry on their work down to the most accurate details. Our mining engineers must be trained to a higher and higher skill to face the growing difficulties."

RAILROAD USES OF WOOD.

A DISCUSSION OF THE IMMENSE CONSUMPTION OF WOOD BY THE RAILROADS AND THE NECESSITY FOR ECONOMY.

Wm. L. Hall--Railway Club of Pittsburgh.

TO no other class of industry has the rapid exhaustion of the forest reserves of the United States presented a problem of greater moment than it has to the railroads. Railroads have always been large consumers of wood but the great activity in railroad building in the last few years has increased the annual consumption to enormous figures. The peculiar requirements of railroad construction have demanded the use of the highest quality of certain limited classes of timber and the increasing scarcity of suitable woods is one of the largest problems with which the railroads have to deal.

Probably the largest item in railroad uses of wood is that of ties, and to show the immense annual consumption of timber to supply this one requirement, the following extracts are taken from the report of the United States Forest Service for 1905.

"The following report upon the cross-ties purchased by the railroads in 1905 is based upon statements from 770 steam railroad companies. Of those which failed to report, only one operates more than 1,000 miles of track, and that one less than 1,300. The average mileage of the remainder is approximately 45. The total mileage unreported is 8,671. Since the total trackage in the United States on January 1, 1905, was, according to Poor's Manual, 293,937 miles, the unreported trackage amounts to but 2.9 per cent. of the total.

"The total number of ties reported is 77,981,227, switch ties being reduced to an equivalent number of cross-ties. Of the total number of ties purchased, 14,459,521, or approximately 18.5 per cent., were for use in the construction of new track, leaving 63,521,706 for renewals. It will be noted that this is less than the total announced in the preliminary statement made by the Forest Service under date of May 17, 1906. This is the result of a correction for duplication made in compiling the preliminary report. Assuming that the unreported 2.9 per cent. of trackage required ties in the same proportion as the reported trackage, the total number of ties purchased by the steam railroads of the United States in 1905 was 81,562,150. Estimating 10,000,000 additional ties for the electric lines, the total number of ties purchased last year in the United States was, in round numbers, 91,500,000.

"The four leading kinds of timber for ties are oak, pine, cedar and chestnut, which combined furnish 83 per cent. of the total number, oak and pine alone furnishing 68 per cent. Next in rank is the red fir of the Pacific Coast and Rocky Mountain region with 4.6 per cent., followed by the cypress of the South with 4.5 per cent. The tamarack, or eastern larch of the New England and Lake States, and the eastern hemlock are the only other species credited with more than 1 per cent. of the total number. Beech, birch, and maple were reported in amounts of less than one-tenth of 1 per cent. each. The miscellaneous classification includes a number of woods, among which the most important are red gum, black locust, elm, hickory, and red cedar. Thus some twenty kinds of timber enter into the production of railroad ties, but of these only seven, at most, are important.

"Until a comparatively short time ago the railroads were usually able to secure an ample supply of ties from lands adjacent to their rights of way. This has been especially true of the vast network of lines which traverse the territory east of the Mississippi River. While this source is by no means exhausted, it has become seriously depleted, and where in former years the purchasing agent could contract for an almost unlimited number of white-oak ties with the assurance that they would be promptly furnished, at the present time it is necessary to contract for small quantities and to anticipate the demand far in advance.

"Where the tie was once the major product, it is now generally a minor product. The Pacific Coast is practically the only region in the United States where ties are produced as a major product of the forest. One of the most important sources of the ties in the East is the farmer's woodlot. During the winter in this region large numbers of ties are hewed and hauled to the railroads."

In a recent paper before the Railway Club of Pittsburgh, Mr. Wm. L. Hall, of the United States Forest Service, discussed the increasing scarcity of timber and laid great stress on the necessity of economy in railroad uses of wood. Mr. Hall remarked the progress that has been made in the building of steel cars but stated that it was important that the railroads pay still more attention to the question of replacing wood by steel in the manufacture of rolling stock. The extensive use of wood for station buildings and connecting approaches and platforms insures economy in first cost but ultimate economy can best be attained by the use of brick, stone or concrete for station buildings, and brick, gravel or cement for walks and platforms. Incidentally, the flooring of wharves and docks, in which large quantities of wood are used, might well be constructed of some more permanent material.

"In bridge construction there is a general movement toward the replacement of wood by masonry or steel, even in small structures. Steel and stone after thorough trial have evidently proved more acceptable materials. In spite of this tendency the Committee on Wooden Bridges and Trestles of the American Railway Engineering and Maintenance of Way Association claims that 'It will be a very long time before wooden trestles cease to be used on most of our railroads.' A large amount of high grade timber is used every year in bridge and trestle construction. This timber should be made as permanent as possible by preservative treatment. Such timbers do not as a rule wear out, they deteriorate by action of the weather and they decay. A treatment which makes them resist weather action and decay will correspondingly increase their service. Railroads in the West and South are treating bridge and trestle timbers quite extensively.

"The wooden pile is an article which, so far as I am informed, has not been successfully replaced. Regardless of what may be done to replace wood in other places it seems that the wooden pile must remain in favor indefinitely. A vast quantity of timber is annually cut for piling, and the worst of it is that these fine poles—the best product of the forest—have often vanished within a few months before the onslaught of marine borers when placed in brackish water, or they have decayed within a few years in situations favorable to the growth of injurious fungi. With rising prices we are passing out of conditions which have made such methods practicable. We must use wooden piles but we cannot afford to place them at great expense and then allow them to be immediately consumed by insects or fungi. They must be protected. Experience has taught that the best protection against both insects and decay is a thorough impregnation of creosote. A good quality of creosote stays in the wood indefinitely, and so long as it is there in sufficient quantity neither borers nor fungus will attack it. In economizing in the use of wooden piles, then, we must look, not to substitution, but to the continued use of wood with the best possible protection.

"Another class of railroad timbers which must be considered is made up of telegraph poles and fence posts. These must be had in considerable quantities and the only satisfactory material from which to make them is wood. As in the case of the wooden pile the problem is one, not of substitution, but of protection. Unlike the pile, the telegraph pole and the fence post require protection only for a few feet at the ground end. Decay takes place in a damaging manner only over that part from a few inches above to a few inches below the surface. That is the only part which it is vitally necessary to treat. This simplifies the problem of treatment in one way but complicates it in another. It makes it possible to use less of the preservative, thereby reducing expense, but it makes necessary equipment not found in the ordinary treating plant. Without stopping to discuss the detail of operations, however, which it is not the purpose of this paper to present, let me say that the Forest Service has made careful and extensive experiments in the butt treatment of both poles and posts and the results warrant belief that it is entirely practicable. With relatively small expense a penetration of one-half inch to two inches can be secured. One telephone company is already taking up this form of treatment and probably within a few years it will be in common use."

With regard to the tie situation, Mr. Hall says:

"In your September meeting one of the members of this Club, in discussing the merits of steel and wooden ties, said: 'While I believe that the best tie is a first class white oak tie, 7 inches thick, 9 inches face, 8 feet 6 inches long treated with some preservative, yet we all know that such ties are very scarce and the railroads are about facing the problem of purchasing ties of other material than wood. We need not stop at this time to state just why an oak tie is better than a steel tie. The reasons are many. The superiority of white oak ties is generally recognized by railway engineers in charge of maintenance of way, and the advocates of steel ties do not deny this superiority. The purchase of steel ties is being advocated because timber cannot be procured in sufficient quantities to supply the demand for cross ties. It is no longer possible in the United States to purchase 80,000,000 first class cross ties per year. The supply of durable timber is inadequate.'

"If the first class white oak tie has such manifest advantages over the steel tie I am not certain that we must decide for the latter because white oak is growing scarce. It should be decided first whether other woods can be so protected and used as to obtain the serviceableness of white oak.

"Railroad practice is working in this direction. Tie plates have been introduced with marked success on many roads for the protection of soft-wood ties. A very great advance is being made just now toward the preservative treatment of ties. Ten per cent. of the ties used last year were treated. All efficacious treatment helps because it largely eliminates decay, which has been the greatest factor in weakening ties. There is ground for believing that by certain forms of creosote treatment the tie can be both hardened and strengthened. The form of spike can be bettered so that the union between the tie and rail will be firmer, and the tie thereby protected. The better ballasting of the track will also protect the tie. These means of protection will bring the tie of other woods approximately to the white oak standard, and all these means of protection can be accomplished by most railroads more easily than they can change to the steel tie.

"If we change from the wood to the steel tie we should do so only because all around steel is the best material for the purpose. If steel or concrete or any other material actually proves better than wood then that material ought to be adopted. If wood remains the most acceptable tie material we ought not to discard it on the ground of present scarcity.

"In my opinion, the present situation is to be met, not by hastily abandoning wood in favor of some other material of unproved acceptability which may also in time become scarce. The situation is to be met first, by the use of other materials where we know they are better; second, by the best possible protection to the wood where it proves the best material; third, by protection and care of the forest in order that nature, by its own process of growth, may, through all time to come, supply the wood needed by the industries."

THE RESISTANCE OF MATERIALS.

A DISCUSSION OF THE IMPORTANCE OF CAREFUL STUDY OF THE INFLUENCE OF THE TIME-FACTOR IN THE RESISTANCE OF MATERIALS.

Engineering.

THE doctrine of the essential simplicity of nature has been the basis on which most of the pioneer work in every branch of science has been attempted and it is questionable whether a start would ever have been made in many a line of investigation had not its originators been imbued with a strong sense of the substantial truth of this dogma. In actual experience, however, the principle has been disproved in every branch of science and it is by no means improbable every one of the great generalisations which we term "natural laws" will ultimately be proved to be nothing more than a first approximation to the actual state of affairs, as improved methods of experiment render possible more accurate observation. An editorial in a recent number of *Engineering* points out the necessity of a more thorough investigation of the principles on which the design of all classes of structures is based, with especial reference to the influence of the time-factor in the resistance of materials.

"With respect to the laws governing the strength of materials, sad experience has shown that the simple principles by which the great engineers of the past proportioned their structures are by no means universally applicable. They proceeded on the straightforward and common-sense plan of determining, or assuming, the ultimate strength of their material, and divided this by a factor of safety, in order to fix the proper working load which it would be prudent to permit.

"It was soon found, however, that a factor of safety which experience showed sufficient in one case might be totally inapplicable in another, the variations depending not only on the method of loading, but also with the nature of the material used. Short girder bridges have been commonly built with a nominal factor of safety of 5, and a similar factor is generally used in boiler work. In small arms, however, in which the stresses are very similar in character to those obtaining in a boiler, the factor of safety is less than 2, as pointed out by Mr. Stromeyer in the interesting address which he delivered last November to the Manchester Association of Students of the Institution of Civil Engineers. Here, moreover, the load is an impulsive one, whereas in a boiler the load is remarkably steady, the range of variation being extremely small, and its rate of alteration very slow, both of which are conditions which are generally held to permit of the adoption of a low factor of safety. On the other hand, of course, provision has to be made for the risk of corrosion, which is negligible in the case of a firearm. Mr. Stromeyer rather criticises the use of the term 'factor of safety' at all, and would prefer that a definite working stress should be specified instead, varying with the nature of the material and the condition of loading. This is doubtless the most rational method of procedure, and may be often advantageously adopted, when a reasonably accurate analysis of the stresses obtaining in the structure under consideration is possible. Even then, however, the alternative method has some advantages, as it gives a rather better idea of the extent to which the load may, as an emergency, be temporarily increased. Thus, with a factor of safety of five, it is permissible to test boilers up to twice their designed working pressure; but, obviously, if the factor of safety of a small-bore rifle is under two, a proof pressure of double the working pressure is inadmissible. . . . . .

"The term 'elastic limit' introduces another point in which the simple ideas which guided the early engineers have proved inadequate for the description of the actual facts of experience. It was first found that the elastic limit, as usually defined, was a variable quantity, depending on the previous history of the metal, and that by suitable treatment the limit could, in the case of steel, be raised almost up to the breaking-point. Later on, Bauschinger introduced the idea of an elastic range, and showed that steel had two elastic limits—one for tension and one for compression; and that raising the elastic limit in tension lowered that in compression to a nearly equal degree. He further concluded that to ensure safety in a structure subject to varying stress, the range of stress must not be greater than the elastic range of the material. Here, again, engineers were presented with a simple and readily intelligible explanation of their experience with materials subject to alternating stresses, best exemplified, perhaps, by Wöhler's classical experiments. No sooner, however, had this idea—which is not only plausible in itself, but is undoubtedly to a very large extent, well based—become general property, than matters were again complicated by Professor Osborne Reynolds, who showed that the endurance of a bar under alternating stresses was not merely a function of the range of stress, but depended also on the rapidity of the alternations, so that the hard steels, which in general show much greater endurance than the milder qualities, break down at much the same stresses, if the rate of variation is sufficiently high. This result is a most important one, though undoubtedly in a vast number of practical applications the harder steels do show to great advantage in the matter of endurance. . . . . .

"A matter on which further light is badly needed is the influence of this time factor on the endurance of materials. There is some reason for believing that relatively high stresses, if transient, can be carried without injury to the material; yet this view seems discordant with the experiments of Professor Osborne Reynolds, and also with the experience of high-speed-engine builders. It is known that if a stress is applied to a bar within the so-called elastic limit, the bar does not immediately take its full amount of stretch, but a certain creep continues for some time after the application of the load. Similarly, on the removal of the load, the bar does not recover its original length immediately, there being again a certain amount of creep, which dies away relatively slowly. Some elasticians have assumed, as the basis of their investigations into the resistance of structures, that the safety of the structure was inversely proportional to the maximum strain induced by the stresses; and were this correct, it would seem that bars should be stronger under very rapidly alternating stresses than when the rate of change of stress is slow, since the phenomenon of creep indicates that the molecular displacement should be less in the former case. This view, however, seems negatived by experience; but, on the other hand, no one now accepts Rankine's simple theory that, in the case of compound stresses, safety varies inversely as the maximum tensile or compressive stress in the material. A good deal of light has been thrown on this latter point by the researches of Mr. Guest, which have confirmed the views of many recent elasticians, that the safety varies inversely as the maximum shear.

"Whilst Time, which is proverbially a healer, does appear to have considerable curative abilities in the case of the mechanical overstrain of materials, its influence on other forms of injury appears less beneficial. Mr. Stromeyer, in the paper to which we have already referred, relates that a specimen of steel, on which work had been done at blue heat twenty years ago, proved as brittle when recently tested as similar specimens broken at the time of treatment. Moreover, he has also recently shown grounds for believing that certain kinds of steel have a natural tendency to become brittle with age, even when moderately loaded under steady stresses. Here, again, there is need for an extended investigation into the influence of the time-factor."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Cantilever.

The Blackwell's Island Bridge. Illustrated detailed description of a noteworthy example of eyebar cantilever construction now being erected by the Pennsylvania Steel Co. at New York. 2500 w. Ir Age—March 7, 1907. No. 82788.

Erection of the Cantilever Spans of the Blackwell's Island Bridge. Illustrated description of the erection of this bridge which crosses the two channels of the East River, and over Blackwell's Island at New York. 2200 w. Eng Rec—March 2, 1907. No. 82728.

Cofferdams.

Steel Sheet Piling for Bridge Pier Cofferdams. Illustrated description of the construction of an electric railway bridge crossing the Illinois River at Peoria. 1800 w. Eng Rec—March 2, 1907. No. 82714.

Concrete.

Three-Hinged-Arch Bridges of Concrete (Ponts en Béton à trois Rotules).

Descriptions of two bridges over the Iller River at Lautrach and Kempten, Bavaria, methods of construction, etc. Ill. 2200 w. Génie Civil—Feb. 16, 1907. No. 82984 D.

Connecticut River.

The New Connecticut River Bridge of the New York, New Haven & Hartford Railroad. Illustrated description of the bridge between Lyme and Saybrook, Conn., which will eventually be a four-track structure, though the superstructure for only the two south tracks will for the present be in service. 1200 w. Ry Age—March 22, 1907. No. 83254.

Guatemala.

The Rio Fiscal Bridge on the Guatemala Railway. Diagrams and description of a bridge 350 ft. long between abutments, which has a three-hinge spandrel-braced arch span of 209 ft. flanked by two plate girder approach spans of about 30 ft. each at both ends. 1200 w. Eng Rec—March 23, 1907. No. 83218.

Hudson River.

The New Sandy Hill-Fenimore Concrete-Steel Bridge Across the Hudson River, N. Y. Illustrated description of a structure including 15 arched spans, each 60-ft. in the clear. The exterior walls were of hollow concrete blocks, and the hollow places poured full of cement, making the structure monolithic. 1500 w. Cement—March, 1907. No. 83166 C.

India.

Khushalgarh Bridge. Illustrated detailed description of a steel cantilever bridge now under construction over the River Indus. Plates. 1500 w. Engng—Feb. 22, 1907. No. 82834 A.

Long Spans.

Noteworthy Early Examples of Long-Span Bridge Erection. Frank W. Skinner. An illustrated review of different methods employed on famous bridges. 7000 w. Eng Rec—March 2, 1907. No. 82709.

Mississippi.

Proposed New Bridges Over the Mississippi River at St. Louis, Mo. Map, showing present and proposed bridges, giving some particulars in regard to them. 1500 w. Eng News—March 21, 1907. No. 83206.

Missouri River.

Missouri River Bridge of the Chicago, Milwaukee & St. Paul at Mobridge, S. D. Map showing location, with illustrated detailed description. 3000 w. Ry Age—March 22, 1907. No. 83251.

Movable.

Movable Bridges. C. C. Schneider. A review of the mechanical features of movable bridges, with a set of specifications covering their operating machinery, submitted for discussion and criticism. 13600 w. Pro Am Soc of Civ Engrs—Feb., 1907. No. 83038 E.

Natal.

The Connaught Bridge, Natal. Edward John Stead. A description of this bridge of twelve spans and its erection. 3 plates. 7000 w. Soc of Engrs—March 4, 1907. No. 83172 N.

Nile.

The New Nile Bridges at Cairo. An account of the progress of the work on the three bridges under construction, illustrating the Rodah bridge—535 metres, or 1,755 ft., in length, and having a swing span. 1300 w. Engr, Lond—March 1, 1907. No. 83002 A.

Quebec.

The Erection of the South Anchor Arm of the Quebec Bridge. The equipment of the traveler is illustrated and described and methods of erection explained. 2200 w. Eng Rec—March 2, 1907. No. 82731.

Reconstruction.

The Reconstruction of the Parkersburg Bridge on the Baltimore & Ohio R. R. The amount of traffic and increased weight of locomotives made it necessary to replace the channel spans of this bridge by stronger ones. Illustrates and describes the method of carrying out the work without interruption of traffic and obstruction of the river. 4500 w. Eng Rec—March 9, 1907. No. 82860.

Reinforced Concrete.

Reinforced Concrete Bridge Over the Cumberland River. Ward Baldwin. Illustrates and describes the method of construction. 500 w. R R Gaz—March 22, 1907. No. 83211.

Building the Washington Street Bridge in Dayton, Ohio. A reinforced concrete structure of the Melan arch type, with seven spans, is illustrated and its construction described. 2500 w. Eng Rec—March 2 1907. No. 82715.

Reinforced Concrete Arch Bridges (Bogenbrücke in Eisenbeton). Wilhelm Schnidtmann. Short description of a German railway bridge. Illus. 800 w. Deutsche Bauzeitung—Feb. 6, 1907. No. 82907 D.

The Wallstrasse Bridge in Ulm (Die Wallstrassenbrücke in Ulm a. D.). Herr Neuffer. Description of a reinforced concrete arch bridge of 215 ft. span. Illus. 2900 w Serial. 3 parts. Deutsche Bauzeitung—Jan. 9 and 23, and Feb. 6, 1907. No. 82906 each D.

Replacement.

Erection of the Lehighton Bridge of the Central R. R. of New Jersey. Illustrates and describes the erection of a double-track, through, riveted truss, skew span, to replace an old bridge, with as little interference as possible with traffic. 2500 w. Eng Rec—March 2, 1907. No. 82724.

Susquehanna.

A Long Plate-Girder Bridge and Grade and Alinement Changes on the Lehigh Valley R. R., at Towanda, Pa. Philip H. De Witt. Illustrated description of important improvements in progress. 1200 w. Eng News—March 14, 1907. No. 83130.

The New Lehigh Valley Bridge Over the Susquehanna River, Near Towanda, Pa. Illustrates and describes a 14-span bridge built in connection with railroad improvements at this point. 1200 w. Eng Rec—March 2, 1907. No. 82737.

Swing Bridges.

Design of Swing Bridges from a Maintenance Standpoint. C. H. Cartlidge and discussion. More of a symposium than the regular form of a paper and discussion, considering the subject from the operating and maintenance standpoint. Illus. 24000 w. Jour W Soc of Engrs—Feb., 1907. No. 83184 D.

Timber.

The Long Bridge Across the Potomac at Washington, D. C. Photographs and brief description of one of the oldest timber Howe truss bridges in America, built in 1809 first, and rebuilt in 1834, and repaired more recently. It is now being removed. 700 w. Eng News—March 14, 1907. No. 83138.

Viaducts.

Erection of El Rodes Viaduct, Guatemala Railway. Illustrates and describes the methods of erection. 1600 w. Eng Rec—March 2, 1907. No. 82723.

The Reinforced Concrete Viaduct of the Richmond & Chesapeake Bay Railway at Richmond. Illustrated detailed description of this structure and its construction, with information relating to the work. 2500 w. Eng Rec—March 2, 1907. No. 82708.

Reconstruction of the Amsterdam Viaduct (De vernieuwing van de Westelyke Viaduct te Amsterdam). C. Leemans. Illus. 7500 w. Serial. 1st part. De Ingenieur—Feb. 2, 1907. No. 82957 D.

CONSTRUCTION.

Assuan Dam.

The Assuan Dam Protective Works. Details from the last report of A. L. Webb relating to the preventing of further erosion from the pressure of water discharged through the sluices of the dam. 2500 w. Builder—March 9, 1907. No. 83094 A.

Borings.

Cost of Earth Auger Borings on the New York State Barge Canal. Emile Low. Gives data relative to borings made with fence post hole diggers, or "earth augers," with which some 450 test holes were dug on Section 5. 400 w. Eng News—March 21, 1907. No. 83202.

Methods and Cost of Making Wash Drill Borings on the Great Lakes and Atlantic Ship Canal Survey. A summary of facts given regarding the methods and costs of making wash borings in surveying the possible routes for the proposed ship canal connecting the Great Lakes with Atlantic tide waters. 1700 w. Engng-Con—March 27, 1907. No. 83275.

Methods and Cost of Making Diamond Drill Borings, Deep Waterways Survey, Great Lakes to Atlantic Tide Waters. Gives a record of diamond drill borings of shallow depths, the methods and cost. 1500 w. Engng-Con—March 13, 1907. No. 82868.

Boulevard.

Progress of Construction on the Riverside Drive, New York. An illustrated article describing recent work on this great boulevard. 2000 w. Eng Rec—March 2, 1907. No. 82711.

Building.

The Construction of the Trinity and United States Realty Buildings, New York. Illustrated detailed description of somewhat unusual work carried out in this congested district of New York City. 3800 w. Eng Rec—March 2, 1907. No. 82736.

Checking.

The Checking of Structural Steel Deliveries for Mill Buildings. F. L. Smith. Outlines the methods tried of checking the delivery of material and the inspection necessary to correct defects or inaccuracies before erection. 1600 w. Eng Rec—March 2, 1907. No. 82719.

Concrete.

A Concrete House in the Jamaica Earthquake. Illustrates and describes the concrete building which successfully withstood the shock. 2500 w. Cement Age—March, 1907. No. 83162.

Concrete Blocks.

Concrete Block Construction for Residences, Methods and Costs. Noyes F. Palmer. Discusses concrete block construction in general and also a particular residence at Quogue, Long Island. 2000 w. Engng-Con—March 6, 1907. No. 82783.

Country Houses.

The Engineering of a Country House. Illustrated detailed description of work carried out on a beautiful estate in Surrey, about 24 miles from London, which aimed to equip the estate with all modern applications of sanitary science and electric lighting. 4500 w. Engr, Lond—March 8, 1907. Serial. 1st part. No. 83119 A.

Culverts.

Concrete Pipe Culverts. O. P. Chamberlain, with discussion. Considers the possibilities of this type of culverts. Ills. 7500 w. Jour W Soc Engrs—Feb., 1907. No. 83185 D.

Excavators.

Scraper Excavators. Illustrates and describes types of excavators being used extensively on various kinds of work. 2000 w. Eng News—March 21, 1907. No. 83201.

Foundations.

Concrete Pneumatic Caisson Foundations. Edwin F. Kellogg. A detailed description of the building of foundations for the 41-story Singer Building in New York City. Ills. 2000 w. Cement Age—March, 1907. No. 83161.

The Pneumatic Foundations of the City Investing Building, New York. Describes the property adjacent to this thirty-two story building, and the underpinning methods employed, giving an illustrated description of the difficult foundation work. 4000 w. Eng Rec—March 2, 1907. No. 82722.

Foundation Problems in New York City. C. M. Ripley. An illustrated study of the laying of the foundations for the new building of the Trust Company of America in the Wall St. district, showing the increasing engineering difficulties that must be met. 1800 w. Munic Engng—March, 1907. No. 82694 C.

Difficult Foundations of the Hoffman House Extension, New York. Describes the conditions of adjacent buildings and the bracing and underpinning, the use of steel sheet piles, and the difficult excavation. 3000 w. Eng Rec—March 2, 1907. No. 82733.

Office Building.

A Twentieth Century Campanile. Illustrations showing comparison of the Metropolitan Life Insurance Co.'s tower, 658 ft. above the sidewalk, with other high structures, with remarks on features of construction. 1300 w. Sci Am—March 30, 1907. No. 83298.

Rapid Work.

Another Reinforced Concrete Speed Record. George J. Seymour. Illustrated account of the erection of the new works of the Anderson Carriage Co., of Detroit. 4000 w. Cement Age—March, 1907. No. 83165.

Reinforced Concrete.

French Government Rules for the Design and Construction of Reinforced Concrete. Abstract of instructions prepared for the French Ministry of Public Works, with comments. 2000 w. Eng News—March 21, 1907. No. 83190.

Hints on the Design and Execution of Reinforced Concrete Works. E. P. Goodrich. Suggestive notes from the experience and observation of the writer. 10,000 w. Eng Rec—March 2, 1907. No. 82726.

Reinforced Concrete Construction: Its Proper Application in Earthquake Countries. Charles Derleth, Jr. A discussion of this material, its use, applications, designs, stresses, etc. 4800 w. Jour Assn of Engng Socs—Feb., 1907. No. 83040 C.

Reinforced Concrete Design and Construction. W. P. Day. Discusses some of the factors essential to an economical structure of this material, and gives the safe unit stresses as allowed in a recent report to govern the use of this material in France. Ills. 1800 w. Cal Jour of Tech—March, 1907. No. 83188.

Reinforced-Concrete Construction. William O. Ludlow. From a lecture on Architectural Engineering delivered at Stevens Inst. Tech. Considers, as an example, the planning and construction of an 8-story loft building. 3000 w. Stevens Ind—Jan., 1907. No. 83308 D.

Recent Papers on Reinforced Concrete Construction in Europe (Neuere Vorschriften, betreffend die Bauweise in Betoneisen). Abstract of papers recently read before German Engineering Societies. Diagrams, formulæ. Serial. 1st part. 4400 w. Oest Wochenschrift f d Oeffentlichen Baudienst—Jan. 5, 1907. No. 82930 D.

The Mechanics of Reinforced Concrete. C. B. Wing. Considers the development of formulæ, the principles and methods to be used in application of formulæ, giving comparison of results obtained by formulæ with results of tests. 4800 w. Jour Assn of Engng Socs—Feb., 1907. No. 83039 C.

The Herbivora Building in the Cincinnati Zoölogical Garden. Illustrated description of a recently completed reinforced concrete building having special features of design. 2000 w. Eng Rec—March 2, 1907. No. 82716.

A Chicago Warehouse of Reinforced Concrete Construction. Brief illustrated description of an interesting example of the application of this material to warehouse construction. 1200 w. Eng News—March 28, 1907. No. 83321.

Retaining Walls.

Armored Concrete Retaining Walls. Discusses a design brought forward by M. F. Chaudy, in a communication to the Soc. of Civ. Engrs. of France, which proposes to employ a combination of armored concrete and ordinary masonry, and to introduce horizontal platforms at the back of the walls which will support the weight of earth. Diagrams. 1500 w. Engr, Lond—Feb. 22, 1907. No. 82840 A.

Roads.

The Benguet Road, Luzon, P. I. Brief account of difficult road construction in the Philippine Islands. 1400 w. Eng Rec—March 23, 1907. No. 83220.

Stresses.

The Factor of Safety. J. P. E. C. Stromeyer. Presidential address delivered to Inst. of Civ. Engrs., Manchester Assn. of Students. An interesting discussion of the origin of the expression "factor of safety," and its application to engineering. 4800 w. Engr, Lond—March 8, 1907. Serial. 1st part. No. 83124 A.

Tile.

Cohesive Fireproof Tile Construction. Describes recent work where improved terra-cotta tiles are used. The new Custom House in New York City, and new Madison Square Presbyterian church, furnish examples of domes constructed of this material, and other work is described. 1700 w. Sci Am—March 23, 1907. No. 83147.

Tunnels.

Grade Correction in the Battery Tunnel. The correction of irregularities in the alignment of this tunnel between New York and Brooklyn, the difficult and delicate work of raising the roof and depressing the invert under a heavy pressure, is illustrated and described. 2000 w. Eng Rec—March 2, 1907. No. 82729.

The New York Subaqueous Tunnels. Charles Prelini. The present number outlines the tunnel work in progress round New York City, and later articles will describe four of the more important tunnels. Ills. 2000 w. Engng—March 8, 1907. Serial. 1st part. No. 83113 A.

Progress of work in Lowering the Tunnels Under the Chicago River. William Artingstall. An illustrated account of progress and methods in the lowering of the three street railway tunnels under the river to give the required depth of 26 ft. in the Chicago River. 2000 w. Eng News—March 7, 1907. No. 82796.

The Detroit River Tunnel of the New York Central Lines. Illustrated description of the construction and design of this subaqueous tunnel consisting of riveted steel tubes built on shore, floated and sunk and surrounded by a monolithic mass of concrete. The interiors of the tubes are lined also with concrete 20 in. thick. 3000 w. Eng Rec—March 2, 1907. No. 82720.

Underpinning.

Underpinning a Three-Track Subway. Illustrates and describes methods used for unusually heavy trench bracing. 1500 w. Eng Rec—March 2, 1907. No. 82735.

Methods Used in Underpinning the Singer Building, New York. Describes the conditions to be met and the arrangement for temporary support of a wall on needle-beams until the caisson foundations were completed. Ills. 2000 w. Eng Rec—March 2, 1907. No. 82725.

Shoring a Fifteen-Story Office Building in Chicago. Briefly describes the Champlain store and office building, and the shoring required during the construction of an adjacent building. Ills. 3700 w. Eng Rec—March 2, 1907. No. 82710.

MATERIALS OF CONSTRUCTION.

Beams.

Fundamental Ideas on the Strength of Beams. John D. Adams. A graphical presentation of the stresses in a bending beam, with explanation. 1500 w. Mach, N Y—March, 1907. Serial. 1st part. No. 82766 C.

The Elastic Limit of a Rod under Tension and Bending Strain (Der elastich eingespannte, auf Zug und Biegung beanspruchte Stab). Ivan Arnsvlevic. Mathematical treatment. 2100 w. Oest Wochenschrift f d Offentlichen Baudienst—Jan. 26, 1907. No. 82935 D.

A New Method of Calculation of Beams. A. P. Jacob. Describes a method for computing the section of a reinforced concrete beam. 500 w. Cement Age—March, 1907. No. 83163.

Strains in Beams of Rectangular Section with Curved Axes (Die Beanspruchung stabförmiger Träger mit gekrümmter Mittellinie). C. Pfleiderer. Mathematical treatment. Diagrams. 1400 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 9, 1907. No. 82923 D.

Fire and Load Test of a Reinforced Concrete Beam. H. B. Macfarland. Gives details of an experimental fire and load test. Ills. 1000 w. Eng News—March 21, 1907. No. 83205.

Building Stone.

The Characteristics of Good Building Stones. R. D. George. Discusses their essential qualities, such as strength, durability, workability and color, and the facts determining these qualities. 6000 w. Ores & Metals—March 20, 1907. No. 83231.

Cement.

Comparative Strength Tests of Cement Mortar (Vergleichende Festigkeitsversuche an Körpern aus Zementmörtel). M. Grübler. Description of apparatus and results obtained. Illus. 5700 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 2, 1907. No. 82920 D.

Concrete.

A Normal Concrete. Louis H. Gibson. Discusses the question of the formation of the aggregate in the manufacture of concrete. 2500 w. Munic Engng—March, 1907. No. 82693 C.

Cost of Fence Posts and Other Concrete Work of Dellwood Park. Describes concrete work at an amusement resort in Illinois, giving a report of costs. 1400 w. Eng Rec—March 23, 1907. No. 83213.

The Laws of Proportioning Concrete. William B. Fuller and Sanford E. Thompson. A detailed account of experimental tests made, with results and conclusions, giving many tables, and much valuable information. Ills. 17500 w. Pro Am Soc of Civ Engrs—March, 1907. No. 83328 E.

Corrosion.

Electrolytic Corrosion of Iron and Steel in Concrete. A. A. Knudson. Gives results of laboratory experiments made to obtain data as to the amount of current and time necessary to cause corrosion upon metals incased in concrete or hydraulic cements, and to test their value as electrolytes. Ills. 3000 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83044 D.

The Liability of Reinforced Concrete to Electrolytic Damage. Editorial on the paper of A. A. Knudson, before the Am. Inst. of Elec. Engrs. discussing the electrolytic damage that may affect metal imbedded in concrete. 1300 w. Eng News —March 21, 1907. No. 83203.

Dams.

Experiments on Material for Cold Springs Dam, Umatilla Irrigation Project, Oregon. D. C. Henny and E. G. Hopson. Outlines this project and the earth dam 3,200 ft. long, with a maximum height of 82 ft., explaining the methods of sampling and testing the materials available for its construction. Diagrams. 3500 w. Eng News—March 7, 1907. No. 82795.

Hooped Concrete.

Hooped Concrete and Its Applications (Le Béton fretté et ses Applications). A. Considère. Discusses methods of circular reinforcement and compares this method with ordinary longitudinal reinforcement for columns, etc., giving results of tests of strength, elasticity, etc. Ills. Serial. 1st part. 2000 w. Génie Civil—Feb. 9, 1907. No. 82985 D.

Mortar.

Action of Sea Water on Mortar. Eug. Mayer. A report of trials made at La Rochelle and presented at the Brussels Congress of the International Assn. for Testing Materials. 1500 w. Cement Age —March, 1907. No. 83164.

Reinforced Concrete.

Reinforced Concrete. H. N. Allott. Read before the Manchester Assn. of Engrs. Considers the preparation and use of this material, the working stresses, etc. 2200 w. Prac Engr—March 1, 1907. Serial. 1st part. No. 82886 A.

Tests of Bond Between Concrete and Steel. T. L. Condron. Considers the factors upon which the adhesion depends, and gives results of a series of bond tests made to investigate the relative strength of bond developed by different forms of bars in the same kind of concrete and under otherwise identical conditions. Ills. 4000 w. Jour W Soc of Engrs—Feb., 1907. No. 83186 D.

Accurate Calculation of Compound Construction (Angenäherte und genaue Berechnung von Verbundkonstruktionen). P. Göldel. Mathematical treatment of strength of reinforced concrete. Diagrams. 2500 w. Oest Wochenschrift f d Offentlichen Baudienst—Feb. 2, 1907. No. 82932 D.

Wood.

The Necessity of Economy in Railroad Uses of Wood. William L. Hall. Explains the present situation, showing the railroads to be large users of timber, and the shortage of the product. Suggests that other materials be substituted wherever they are known to be better, protecting the wood where used, and the care of forests. Discussion. Also a copy U. S. Dept. of Agriculture Circular 43, in regard to cross-ties. 9500 w. Pro Ry Club of Pittsburgh—Dec. 28, 1906. No. 83033 C.

MEASUREMENT.

Chaining.

The Method and Apparatus for Chaining Used by the Topographical Bureau, Borough of Queens. George J. Falkinburg. Illustrated description of accurate chaining apparatus. 1500 w. Eng News— March 14, 1907. No. 83137.

Metering Plant.

Venturi Meters at Rio de Janeiro. Illustrates and describes an elaborate plant comprising not less than twenty separate Venturi meters, which will measure the waters received from as many sources of supply, the flow being recorded not only locally but also transmitted to a central station. 2000 w. Engng—Feb. 22, 1907. No. 82835 A.

Roads.

The Viagraph. Illustrations, with brief description of a road-testing machine. It automatically traces every inequality over which it is drawn. 500 w. Sci Am Sup— March 2, 1907. No. 82648.

Survey.

The Ohio River Survey. Roger Baldwin Colton. Brief account of the work below Louisville, Ky., during the summers of 1905-6. Ills. 1800 w. Yale Sci M —March, 1907. No. 83159 C.

Surveying.

Some Tests in Sighting at Leveling Rods and Stadia Rods. John C. Tracy. Presented at meeting of the Connecticut

Soc. of Engrs. Gives the results of four tests made to determine the probable errors in setting a target on a leveling rod; reading a rod directly without using a target; measuring horizontal distances with the stadia; measuring differences in elevation by the stadia and vertical-angle method. 1800 w. Eng News—March 21, 1907. No. 83200.

Transit.

The Verschoyle Pocket Transit. W. Denham Verschoyle. Illustrated description. 800 w. Eng & Min Jour—March 2, 1907. No. 82690.

MUNICIPAL.

Asphalt.

Sheet Asphalt Specifications. Gives the latest specifications for Washington, D. C. 2000 w. Munic Jour & Engr—March 6, 1907. No. 82785 C.

Pavements.

Experience with Various Pavements on Streets with Heavy Grades. C. G. Anderson. Abstract of a paper read before the Ill. Soc. of Engrs. & Survs. Cross-sections and descriptions of styles of paving employed on streets with heavy grades, at Moline, Ill. 3500 w. Eng News—March 14, 1907. No. 83134.

Hassam Pavement. W. A. Luey. Describes this new concrete pavement, named for the inventor, and the manner of laying. 1200 w. Cal Jour of Tech—March, 1907. No. 83189.

Sheet Asphalt Pavements. H. C. Innes. Information relating to the selecting of materials, laying, etc. 3000 w. Munic Engng—March, 1907. No. 82695 C.

The Method, Cost and Results of Tarring Heavily-Traveled Macadam Streets in Chicago. Explains the greater wear on streets due to the extensive use of automobiles, and gives particulars relating to tarring, the results being considered sufficiently satisfactory to justify a continuance of the work. A statement of cost is given. 2200 w. Eng Rec—March 16, 1907. No. 83071.

The Cost of Materials and Wages of Labor for Paving Work in Representative American Cities. Tabulated statements of costs for various kinds of pavement, with remarks. 1000 w. Engng-Con—March, 1907. No. 83276.

Oiled Roads in California. Notes from the biennial report of N. E. Ellery, State highway commissioner, giving extracts from the specifications for the construction of oiled graveled streets. 2000 w. Eng Rec—March 23, 1907. No. 83215.

Pipe Subways.

Pipe Subways in British Cities and in Paris. Illustrates and describes subways in a number of foreign cities, giving information regarding cost and other matters of interest. 7500 w. Eng News—March 14, 1907. No. 83132.

Road Traffic.

The Illinois Road Traffic Census. A. N. Johnson. Abstract of a paper read before the Ill. Soc. of Engrs. & Survs. Gives results of a systematic effort to obtain information in regard to traffic conditions and their effect on the roads, etc. 1800 w. Eng Rec—March 16, 1907. No. 83070.

Septic Tanks.

Decision in the Cameron Septic Tank Suit Against Saratoga Springs, N. Y. Gives the decision of Judge Ray, in this suit in equity to restrain alleged infringement and for an accounting. Reviews the claims of the Cameron patent and of many phases of earlier sewage treatment. 12000 w. Eng News—March 28, 1907. No. 83322.

Sewage.

Hydraulic Sewage Ejector on Lake Ave. South, Duluth, Minn. E. A. Wilson. Illustrates and describes an apparatus for elevating the sewage from a low district, explaining the conditions it was designed to meet. 1300 w. Eng Rec—March 9, 1907. No. 82865.

Regulations for Sewage and Roof Water Disposal on Unsewered Premises, Havana, Cuba. Gives some interesting regulations providing for the construction of miniature septic tanks and of absorbing basins for rain water, pending the completion of a new sewerage system at Havana. 1000 w. Eng News—March 14, 1907. No. 83136.

Municipal Sewage Experiment Stations. Editorial discussion of the progress made in sewage treatment, with suggestions for subjects still needing investigation in connection with this work. 3000 w. Eng News—Feb. 28, 1907. No. 82675.

The Experimental Sewage Treatment Works for Baltimore, Md. Illustrated detailed description of an experimental plant being installed to gain information for use in designing proposed sewage works for the city. 1200 w. Eng News—Feb. 28, 1907. No. 82673.

The Municipal Sewage Experiment Station, of Waterbury, Conn. William Gavin Taylor. Describes the local conditions which must be met, and gives an illustrated description of an experiment station and testing work being carried out. 4500 w. Eng News—Feb. 28, 1907. No. 82674.

Examination and Purification of Sewage (Abwasserfrage und Abwasserreinigung). A. Nolte. System of treatment in use in Cologne and other cities of Europe described. Illus. Serial. 2 parts. 5100 w. Stahl u Eisen—Jan. 23 and 30, 1907. No. 82950 each D.

The Sewage Disposal Works at Kirksville, Mo. Plan and description of a system carrying domestic sewage only. The disposal works consist of septic tanks, contact beds, and intermittent sand filters, and one bed is sterilized by a solution of copper sulphate before being discharged. 1800 w. Eng Rec—March 23, 1907. No. 83222.

Sewers.

The Bronx Storm Relief Sewer Tunnel. A sewer under construction from Webster Ave. to the Harlem River is illustrated and described. 4000 w. Eng Rec—March 2, 1907. No. 82721.

WATER SUPPLY.

Analysis.

The Use of Lactose Bile Media in Water Analysis. Daniel D. Jackson. Abstract of a paper read before the Am. Pub. Health Assn. Concludes that by the employment of this new media more definite results on the sanitary quality of a water may be obtained than by any other test at present in use. It is also especially valuable in the testing of filter plants. 1000 w. Eng News—March 14, 1907. No. 83131.

Colorado River.

The Lower Colorado River and the Salton Basin. C. E. Grunsky. Information based on official reports upon results of examinations made of the Colorado River's low-water course; and an account of the attempt to turn the river back into its proper channel after its overflow into the Salton Basin. Ills. 18200 w. Pro Am Soc of Civ Engrs—Feb., 1907. No. 83037 E.

Dams.

Technical Conditions Determining the Design of Dams (Norme techniche che dovrebbero presiedere al connaudo dei muri di sbarramento). Domenico Barsanti. Diagram. 2500 w. L'Elettricita—Jan. 25, 1907. No. 82902 D.

Filtration.

The Mechanical Filters of the Water Works of Harrisburg, Pa. Describes some of the leading features and methods of operation. Ills. 6500 w. Eng Rec—March 9, 1907. No. 82864.

Freezing.

The Freezing of Water Plugs (L'Incongelabilité des Bornes-Fontaines). A. Bergés. Methods of preventing freezing of water plugs and types of apparatus designed for this purpose. Ill. 2500 w. Génie Civil—Mar. 9, 1907. No. 82077 D.

Germany.

Water Economy and Storage in Germany (Die Wasserwirtschaft und der Talsperrenbau in Deutschland). Emil Grohmann. Review of different sources of water supply, and location of dams. Illus. 2200 w. Oest Wochenschrift f d Oeffentlichen Baudienst—Feb. 16, 1907. No. 82929 D.

Irrigation.

Irrigation and the Government Irrigation Project at Yuma. Prof. Oscar C. S. Carter. Reviews the early history of irrigation in various parts of the world, and describes the conditions in the semi-arid and arid regions of the United States, and the irrigation projects under consideration and construction, with information relating to the Yuma project. Ills. 7000 w. Jour Fr Inst—March, 1907. No. 83171 D.

The Minidoka Irrigation Project, U. S. Reclamation Service. C. J. Blanchard. Illustrated description of the dam and distributing system of this reclamation work in Idaho. 3000 w. Eng Rec—March 2, 1907. No. 82713.

Isolated House.

Water Supply for the Farm Home. Elmina T. Wilson. Extract from a Bul. of the U. S. Dept. of Agriculture, relating to the water supply of farm homes. 3000 w. Met Work—March 30, 1907. No. 83319.

Pennsylvania.

The Work of the Pennsylvania Water Supply Commission. An account of the work undertaken by this commission, what has been accomplished, etc. 3300 w. Eng Rec—March 16, 1907. No. 83067.

Pipe Lines.

Methods Employed in Laying Three Submerged Pipe Lines. Frederick S. Wardwell. Read before the Conn. Soc. of Civ. Engrs. Describes the methods of laying outfall pipes at Stamford and at Shippan Point, and a pipe across the Housatonic River, at Shelton, Conn. 2000 w. Engng-Con—March 6, 1907. No. 82784.

A 48-in. Riveted Steel Pipe Line at Kansas City, Mo. C. K. Allen. An account of difficulties encountered in laying these large water pipes, describing and illustrating methods of construction. 2000 w. Eng Rec—March 2, 1907. No. 82730.

Pollution.

Report on the Pollution of the Water Supply of Philadelphia by Coal Wastes. Gives the report of Messrs. Fairchild and Gilchrist on coal dirt pollution. 2000 w. Eng News—March 21, 1907. No. 83204.

Contamination of the Water Supply of the City of Breslau (Uebelstände in der Grundwasserversorgung der Stadt Breslau). A. Friedrich. Discussion of the analysis and suggestions for improvement. 1200 w. Oest Wochenschrift f d Oeffentlichen Baudienst—Feb. 9, 1907. No. 82936 D.

Purification.

Contractor's Plant and Methods Water Purifying and Softening Works, Columbus, Ohio. George E. Howe. An illustrated general description of a pumping station to house the pumps to be used for supplying the purifying and softening works with water and to deliver water from them to the city. 2200 w. Eng Rec—March 2, 1907. No. 82727.

Water Purification at Fostoria, O. Illustrations, with description of a recently constructed sand filter, taken from a paper by W. J. Sherman. 700 w. Eng Rec—March 23, 1907. No. 83219.

Reclamation.

The Reclamation of the North Platte Valley. W. S. Coulter. An illustrated description of the North Platte irrigation project. 1800 w. Pop Sci M—April, 1907. No. 83279 C.

Reservoirs.

The Cobb's Hill Reservoir, Rochester, N. Y. Illustrates and describes the concrete work of a 140,000-gal. reservoir now under construction. 4000 w. Eng Rec—March 2, 1907. No. 82717.

Siphon.

Reinforced Concrete Siphon of the Rio Sosa, Spain (Siphon en Beton Armé du Rio Sosa). Henry Martin. A siphon system for supplying 370 cubic feet of water a second for irrigation projects in Spain. Ill. 5800 w. Génie Civil—Mar. 16, 1907. No. 82971 D.

Sprinkler Systems.

Sprinkler Systems of Fire Protection in the Claflin Store Building, New York. Plans and description of the distribution of heads and arrangement of piping for a 10-story and basement structure. 1600 w. Eng Rec—March 9, 1907. No. 82863.

Water Tunnel.

The Seven-Foot Polk Street Water Tunnel, Chicago. Explains why the new tunnel was necessary and gives an illustrated description of its construction. 3000 w. Eng Rec—March 16, 1907. No. 83065.

WATERWAYS AND HARBORS.

Breakwater.

The Concrete Breakwater at Harbor Beach, Mich. Emile Low. An illustrated description of a new superstructure of concrete being erected on the foundations of an old breakwater. 2500 w. Eng News—March 28, 1907. No. 83320.

Canals.

The Proposed Niagara Ship Canal. Describes present conditions at the western terminus of the Erie Canal, and the proposed improvements of Black Rock harbor and channel. Illustrates the Lobnitz rock-cutter which will be used. 1500 w. Eng Rec—March 16, 1907. No. 83066.

The St. Lawrence Route. S. J. McLean. A review of the canal section, its development and improvement, with information concerning the canal traffic. Map. 2500 w. Ry Age—March 1, 1907. Serial. 1st part. No. 82705.

The Kom-Ombo Irrigation Canal. Illustrated detailed description of interesting work in connection with an extensive irrigation scheme in Egypt. Relates to the supply and erection of a riveted steel canal, about a mile in length, and the supply and erection of two riveted steel rising mains. 2500 w. Engr, Lond—March 8, 1907. No. 83120 A.

Steam Pile and Sheet-Pile Drivers on the New York Barge Canal. Emile Low. Illustrates and describes the pile-drivers and excavators used, and the methods of carrying out the work. 1500 w. Eng Rec—March 2, 1907. No. 82734.

Colorado River.

Closing the New Break in the Colorado River. H. T. Cory. An illustrated description of the break occurring in Dec., 1906, and the method of closing it. 3000 w. Eng Rec—March 2, 1907. No. 82732.

Floating Derrick.

Forty Ton Floating Derrick (Schwimmkran von 40 t. Tragfähigkeit). Adolf Beran. A self-propelling floating derrick for use in and about harbors. Illus. 1700 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 2, 1907. No. 82916 D.

Haulage.

Electric Haulage on Canals. An outline of the evidence given by E. W. Marchant on behalf of the London Chamber of Commerce to the Royal Commission on Canals and Inland Waterways. 3500 w. Elec Engr, Lond—March 15, 1907. No. 83264 A.

Loire.

Attempts to Regulate the River Loire (Essais d'Aménagement de la Loire). Ch. Dantin. An illustrated account of the attempts that have been made to make the Loire fit for navigation between Nantes and the confluence of the Maine. Ill. 5000 w. Génie Civil—Feb. 2, 1907. No. 82987 D.

Mississippi Valley.

"Fourteen Feet Through the Valley." Harry B. Hawes. Discussing the project of constructing a 14-ft. channel from Lake Michigan through the Mississippi River to the Gulf. 4000 w. Jour Assn of Engng Soc's—Feb., 1907. No. 83041 C.

Sea Defences.

Ferro-Concrete Sea Defences. Illustrates and describes a system of defence which is said to have proved very successful in Holland. 2000 w. Engr, Lond —March 1, 1907. No. 83001 A.

Teltow.

Electric Installations on the Teltow

Canal (Les Installations Electrique du Canal de Teltow). Georges Dary. This first article of the series describes the Canal, the country through which it passes and especially the locks. Ill. Serial. 1st part. 1800 w. L'Elec—Feb. 16, 1907. No. 82996 D.

Tiber.

Improvement Work on the Tiber (I Lavori del Tevere). G. Como. A description of the work to improve navigation on the Tiber and to protect its banks. Map. 6000 w. Rivista Marittima—Feb., 1907. No. 82979 E + F.

Waterways.

A Plea for the Development of the Waterways. Hon. Joseph E. Ransdell. Address delivered before the Upper Mississippi Improvement Association. 7000 w. Marine Rev—March 21, 1907. No. 83209.

Protected Waterway from Boston to the Gulf. Hon. John H. Small. Discusses the movement for the construction by the United States of inland waterways extending from New England along the entire Atlantic seaboard to the Gulf of Mexico. 3500 w. Mfrs' Rec—March 21, 1907. No. 83207.

MISCELLANY.

Drainage.

Drainage of Bottom Lands Along the Mississippi and Missouri Rivers. Gives abstracts of two papers read at meeting of the Illinois Society of Engineers and Surveyors. I. The Sny Island Levee Drainage District, by W. P. Bushnell. II. The Barton East Drainage System, Nebraska, by L. G. Hicks. 3000 w. Eng News—March 14, 1907. No. 83133.

Earthquake.

The Effects of the San Francisco Earthquake of April 18th, 1906, on Engineering Constructions. Reports of a general committee and of six special committees of the San Francisco Association of Members of the Am. Soc. C. E. Ills. 20700 w. Pro Am Soc of Civ Engrs—March, 1907. No. 83329 E.

Engineering.

President's Address before the North-East Coast Institution of Engineers and Shipbuilders. W. H. Dugdale. An interesting summary of engineering from the earliest times, showing the value of scientific and technical institutions. 8500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Jan., 1907. No. 82822 N.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

The Management and Operation of Ship and Shore Wireless Telegraph Stations. A. Frederick Collins. The sixth of a series of articles dealing with the design, construction and operation of a 100-mile wireless telegraph. 2200 w. Sci Am Sup—March 16, 1907. No. 83021.

Recent Practice in Wireless Station Construction. G. H. Barbour. Illustrates and describes various designs of stations for wireless work, especially the masts and their erection. 3500 w. Elec Wld—March 2, 1907. No. 82773.

Controlling Torpedoes by Wireless Telegraphy. Describes a torpedo launching apparatus, operated by electric waves, which has recently been tried in France. Diagrams. 1000 w. Sci Am—March 23, 1907. No. 83151.

Wireless Telegraphy Between Newhaven and Dieppe. Explains conditions which made the establishment of a wireless station desirable, and gives an illustrated description of the station and its equipment. 2000 w. Engng—March 8, 1907. No. 83117 A.

Carborundum and Silicon Detectors for Wireless Telegraphy. A. Frederick Collins. Describes detectors recently brought out by Gen. H. H. C. Dunwoody, and by Pickard. 900 w. Sci Am—March 16, 1907. No. 83019.

Wireless Telegraph Receivers. S. M. Kintner. Discussing improvements made in detectors, especially commending the liquid barretter and its various modifications. 1800 w. Pro Am Inst of Elec Engrs—Jan., 1907. No. 83024 D.

Telephony.

Telephone Retrospection. W. D. Sargent. Brief review of the development. 1800 w. Elec Rev, N Y—March 9, 1907. No. 82877.

The Storage Battery in Telephony. C. E. Paxson. Considers the methods of design of central office storage batteries from the point of messages. 2000 w. Elec Wld—March 16, 1907. No. 83127.

Multiple Control Arrangement for the Nuremberg-Fürth Telephone Line (Vielfach Umschalte Einrichtungen für die Fernsprech Anlage Nürnberg-Fürth). J. Jacob. Detailed description. Illus. Serial. 2 parts. 8600 w. Elektrotechnische Zeitschrift—Feb. 14 and 21, 1907. No. 82963 each B.

Telharmonium.

The Telharmonium—An Apparatus for the Electrical Generation and Transmission of Music. An illustrated description of the New York plant embodying the system of Dr. Thaddeus Cahill. 2200 w. Sci Am—March 9, 1907. No. 82808.

The Telharmonic System of Producing Music Electrically. Illustrates and describes the telharmonium, an electrical machine for the production of music, and the system of distribution. 1000 w. Eng News—Feb. 28, 1907. No. 82672.

DISTRIBUTION.

Cables.

Underground Transmission and Distribution of Electrical Energy. Charles E. Phelps. A brief study of the faults in cables, showing that most of them can be avoided. 1600 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83047 D.

Conduits.

Installing Feeder Conduits in Fireproof Buildings. T. W. Poppe. Calls attention to points needing care. Ills. 900 w. Elec Wld—March 2, 1907. No. 82776.

Faults.

Localization of Faults on a Three-Wire Network. F. Fernie. Briefly describes methods used with success. 2000 w. Elec Rev, Lond—March 15, 1907. No. 83266 A.

Insulation.

Electric Strength and Resistance of Two Different Insulating Materials in Contact (Elektrische Kraft und Durchschlagsfestigkeit in zwei hintereinander geschalteten Isolierstoffen). Gustav Benischke. Diagrams and formulæ. 1500 w. Elektrotechnische Zeitschrift—Jan. 31, 1907. No. 82939 B.

Insulators.

New Methods of Fastening Insulators. Carl Egner. Translated from the *Teknisk Tidskrift.* Illustrated description of this new method, the essential part being the use of insulating caps of extra strong, durable paper, impregnated with insulating material. 1200 w. Elect'n, Lond—March 8, 1907. No. 83110 A.

Switchboards.

Some Aspects of Modern Switchboard Engineering. C. W. Stone. Read before the N. Y. Elec. Soc. Aims to point out some undesirable features to avoid, and to explain why some things are done. Ills. 5000 w. Elec Rev, N Y—March 9, 1907. No. 82880.

A General Solution of Change-Over Switch Problems. Frank M. Denton. Suggests a practical general solution of the problem of changing over from one diagram of connections to another, by means of throw-over switches, using the smallest possible number of blades and contracts. 500 w. Elec Wld—March 23, 1907. No. 83239.

Remote Control High-Tension Switch Gear. Frank Walker. Abstract of a paper read before the Glasgow Loc. Sec. of the Inst. of Elec. Engrs., containing a description of the L. C. C. tramways, Greenwich power station switch gear. Ills. 3000 w. Mech Engr—March 2, 1907. Serial. 1st part. No. 82889 A.

DYNAMOS AND MOTORS.

Alternating Current.

Alternating Current Machine with Separately Excited Field (Wechselstrom Maschine mit Hilfsfeld und verketteter Erreger Maschine). A. Heyland. Theoretical treatment of the action of such machines. Diagrams and table. 7800 w. Serial. 2 parts. Elektrotechnische Zeitschrift—Feb. 7 and 14, 1907. No. 82961 each B.

Armature Reaction.

Effect of Armature Reaction in Synchronous Motors and Rotary Converters. B. T. McCormick. States the laws upon which the diagram depends, and explains the construction of the general synchronous motor diagram and the rotary converter. 1500 w. Can Soc of Civ Engrs—March 14, 1907. No. 83288 N.

Heating.

Researches on the Heating of Armatures and Field Coils. Ludwig Ott. Illustrated description of experiments carried out in the Munich Technical High School. 2200 w. Elect'n, Lond—March 8, 1907. No. 83111 A.

The Iron Losses in Asynchronous Machines. Thomas F. Wall. The losses in these machines are mentioned, with special reference to the pulsation of the flux in the teeth. Experiments are described. 2000 w. Elect'n, Lond—March 1, 1907. Serial. 1st part. No. 82892 A.

Principles.

Elementary Principles of Dynamos. Clarence Renshaw. Explanation, with diagrams. 700 w. Ry & Loc Engng—March, 1907. No. 82703 C.

Railway Motors.

The Anatomy of a Railway Motor and Control Equipment. James Lyman. Gives briefly the fundamental principles governing electricity and magnetism, and their application to the railway motor and controlling equipments, discussing train control and related topics. Ills. Discussion. 10700 w. Pro W Ry Club—Feb. 19, 1907. No. 83158 C.

The Inter-Pole Railway Motor. C. A. Mudge. Explains the advantages of the use of inter-poles in railway motors. 2000 w. Elec Wld—March 9, 1907. No. 83014.

Large Single Phase A. C. Locomotive Motor (Grosser Lokomotivmotor für Einphasen-Wechselstrom). E. C. Zehme. A 300 h.p. motor of the Eichberg-Winter type. 350 w. Elektrotechnische Zeitschrift—Feb. 7, 1907. No. 82960 B.

Single Phase.

Slip, Torque and Stator Loss in Single-

Phase Motors (Schlüpfung, Drehmoment und Statorverluste des Einphasenmotors). Adolf Thomälen. Mathematical treatment. Diagrams and formulæ. 2100 w. Elektrotechnische Zeitschrift—Feb. 28, 1907. No. 82966 B.

Windings.

Calculation of Auxiliary Pole Windings. Arthur Keller. Explains the calculation of the ampere-turns required to produce the commutating fluid. 2000 w. Elec Wld—March 9, 1907. No. 83016.

A Method of Calculating the E. M. F. of Polyphase and Single-Phase Windings. H. Görges. Abstracted from *Elektrotechnische Zeitschrift.* The author establishes an ampere-turn vector diagram by means of which the space wave-shape of the magnetic flux, and the flux through each tooth, may be determined at any instant. 1500 w. Elect'n, Lond—March 1, 1907. No. 82893 A.

ELECTRO-CHEMISTRY.

Accumulators.

Experiments on the Distribution of Current in Accumulators. U. Schoop. Abstract translation. A study of the distribution of current in accumulators, and the way in which the electrolyte conducts the current, especially the action of the "electrolytic shunt." 2200 w. Elect'n, Lond—March 1, 1907. No. 82894 A.

Black-Nickel.

Deposition of Black-Nickel in the Plating Barrel. Wilbur G. Stratton. An account of methods that gave a satisfactory deposit. 700 w. Brass Wld—March, 1907. No. 83284.

Copper Peroxide.

Production of Peroxide of Copper by Electrolysis (Bildung von Kupferperoxyd durch Elektrolyse). E. Muller and F. Spitzer. Diagram. 1600 w. Zeitschr für Elektrochemie—Jan. 25, 1907. No. 82915 G.

Electrolysis.

Alternating-Current Electrolysis. J. L. R. Hayden. A report of investigations made to determine to what extent alternating currents passing between any metallic conductor and the ground would produce electrolytic corrosion. Gives conclusions. 5800 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83043 D.

Electroplating.

The Electrodeposition of Brass and Bronze and the Maintenance of the Solutions. Reviews the history of brass plating and gives much information. 3000 w. Brass Wld—March, 1907. Serial. 1st part. No. 83283.

Soldered Nickel Anode Hooks. Paul Johnson. Explains the advantage of soldering the anodes and method of doing it. 600 w. Brass Wld—March, 1907. No. 83282.

Energy.

Electrical and Chemical Energy. Gustaf M. Westman. Makes a comparison between the kinetic energy of gases and the electric current, and shows the relation between chemical and electrical energy, considering also how the current is conducted. 2500 w. Jour Fr Inst—March, 1907. No. 83170 D.

Nitrogen.

Fixation of Atmospheric Nitrogen. Abstract translation of portions of a paper by Dr. Georg Erlwein, published in *Elektrotechnische Zeitschrift.* Deals with researches in this field, and the processes relating to the manufacture of calcium cyanamide, discussing its practical applications. Ills. 2500 w. Elec-chem & Met Ind—March 10, 1907. No. 82871 C.

Fixation of Atmospheric Nitrogen by Calcium Carbide (La Fixation de l'Azote atmosphérique par le Carbure de Calcium). Henri Demierre. Brief description of the process. 1600 w. Bulletin Technique de la Suisse Romande—Jan. 25, 1907. No. 82914 D.

ELECTRO PHYSICS.

Alternators.

Magnetic Oscillations in Alternators and Their Bearing Upon the Design. G. W. Worrall. Gives results of a series of experiments made to determine the amount of the oscillations of magnetic flux in the poles of alternators, and also in the interpolar space. 2000 w. Elect'n, Lond—Feb. 22, 1907. No. 82828 A.

Conduction.

Electric Conduction in Metals. Abstract of a lecture by J. J. Thompson before the Inst. of Elec. Engrs. An account of the modern theory and the results thus far accomplished. 3500 w. Engng—March 1, 1907. No. 82898 A.

Conductivity.

The Modern Theory of Electrical Conductivity of Metals. Prof. J. J. Thomson. Lecture before the Inst. of Elec Engrs. Gives the electron or corpuscle theory of electrical conduction in metals, and an explanation of the Hall effect. 5500 w. Elec'n, Lond—March 15, 1907. No. 83267 A.

Conductors.

Some Newly Observed Forces Within an Electric Conductor. Abstract of a paper by Dr. E. F. Northrup giving a summary of experiments made and conclusions reached. Also editorial. 2500 w. Elec Wld—March 9, 1907. No. 83017.

Divided Circuits.

Theory of Alternating Currents in Divided Circuits (Zur Theorie der Wechselstrom Verzweigung). Leo Lichtenstein. Mathematical treatment. Diagrams and formulæ. 4400 w. Elektrotechnische Zeitschrift—Feb. 7, 1907. No. 82958 B.

Electric Waves.

Ionized Gas Electric Wave Detectors. C. Tissot. Translated from the *Jour. de Physique.* An account of experimental investigations. 1800 w. Elect'n, Lond—Feb. 22, 1907. No. 82829 A.

Apparatus for Measuring Electric Wave Lengths (Construzione Di Un Cumometro Per Radiotelegrafia). P. Barreca. Ills. 3500 w. Rivista Marittima—Nov., 1906. No. 82904 E + F.

Oscillographs.

Investigation of High-Frequency, High Potential Oscillating Discharges by Means of the Braun Tube. E. L. Weber. Describes an experiment for the purpose of obtaining a direct graph of the wave form of a high-frequency, high-potential oscillating discharge, by using the Braun cathode ray tube. Short editorial. 1500 w. Elec Wld—March 9, 1907. No. 83015.

X-rays.

The Roentgen Ray and Its Uses. E. W. Caldwell. Reviews some of the results accomplished, giving a statement of the appliances and methods used. 2200 w. Elec Rev, N Y—March 9, 1907. No. 82878.

GENERATING STATIONS.

Accumulators.

The Soulier Apparatus for Charging Accumulators by Means of Alternating Current (L'Appareil á Charger les Accumulateurs au moyen de Courants Alternatifs). H. Fontaine. Illustrated description. 1800 w. Bull de la Soc d'Encour. Feb., 1907. No. 82974 G.

Alternators.

Alternator Troubles. A. E. Buchenberg. Discusses troubles due to excessive heating and poor voltage regulation of electrical machines. 2000 w. Elec Wld —March 2, 1907. No. 82775.

Balancing.

The Balancing of the Greenwich (L. C. C.) Engines. W. E. Dalby. Gives facts concerning the vibrations produced by the engines installed, taken from the report of the Committee appointed to inquire into the working of the generating station at Greenwich, in its relation to the Royal Observatory. 1700 w. Prac Engr—March 1, 1907. No. 82885 A.

Breakdowns.

Breakdowns of Electrical Machinery. Llewellyn Foster. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Calls attention to the commoner forms of breakdown occurring more particularly in continuous-current machines. Considers the stationary parts carrying current, and not carrying current; and the moving parts carrying, and not carrying current. 3800 w. Mech Engr—March 9, 1907. No. 83105 A.

Economics.

Central Station Supply Economics; Their Study, and What It Promises in the Way of Cheaper Supply. A. M. Taylor. Paper read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Gives a method of separating running charges from fixed charges, showing how to divide the costs. Considers the effect of internal diversity factor, and suggests a method of using accumulators. 7700 w. Elect'n, Lond—Feb. 22, 1907. No. 82826 A.

Generators.

Introduction to Discussion on the Practicability of Large Generators Wound for 20,000 Volts. B. A. Behrend. Principally a consideration of steam-turbine generators for large capacity, 7,500 kw. to 1,500 kw. and above. 1000 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83050 D.

Hydro-Electric.

Electric Transmission System of the York Haven Water and Power Company. Illustrated description of a large power development on the Susquehanna River. Some of the unusual features are the arrangement of the turbines and the crossing of the river by high-tension cables laid in the river bed. 3500 w. Elec Wld—March 2, 1907. No. 82771.

The Highest Hydro-Electric Transmission Plant in the World. Brief illustrated description of the plant for working the Caylloma silver mines, in Peru. 1400 w. Min Jour—Feb. 23, 1907. No. 82831 A.

The Hydro-Electric Plant of the Towaliga Falls Power Co., Griffin, Ga. Illustrates and describes a water power development by which some 3,000 h. p. are rendered available from a stream having a minimum flow of 100 second-feet. 2500 w. Eng Rec—March 9, 1907. No. 82862.

The Shawinigan Hydro-Electric Power Plant. Wallace C. Johnson. An account of the latest developments and extension of the great station at Shawinigan Falls, Canada. Maps and Ills. 2000 w. Cassier's Mag—March, 1907. No. 83028 B.

Isolated Plants.

Regulation in Isolated Plants. Dr. Louis Bell. Gives records of voltage tests made on four typical isolated plants, and also a voltage curve from central station service, with comments. 1200 w. Elec Wld—March 2, 1907. No. 82772.

Neasden.

The Generation of Power at Neasden. A statement of the technical and economic results of the working of this station of the Metropolitan Railway, describing the methods. 4000 w. Engr, Lond—March 1, 1907. No. 83003 A.

Niagara.

Power Development at Niagara Falls (Utilisation des Chutes du Niagara).

Henry Arban. Describes the generating stations, distribution systems and transmission lines of the Niagara Falls Power Company and the Ontario Power Company. Ills. 3500 w. Soc Belge d'Elec—Feb., 1907. No. 82989 F.

Power Plants.

New Power Plant of the Potomac Electric Power Co. of Washington, D. C. Illustrated detailed description of a recently completed 10,000-kw. plant having a concrete building and steam-turbine units. 3500 w. Eng Rec—March 16, 1907. No. 83072.

The Long Island City Power Station. A. D. Williams, Jr. An illustrated detailed description of one of the stations which will furnish power to operate the Pennsylvania R. R. tunnel under New York City. 3800 w. Engr, U S A—March 15, 1907. No. 83092 C.

Friedenau Electric Power Station (Das Elektrizitatswerk der Gemeinde Friedenau bei Berlin). Max Mulertt. A station operated by two Diesel engines of 300 h. p. each. Ills. 1400 w. Elektrotechnische Zeitschrift—Feb. 7, 1907. No. 82959 B.

Rhine.

The Water-Powers of the Rhine Near Laufenburg. Illustrated description of proposed utilization of the Rhine, which will prove one of the most important water-power plants on the European Continent. 1500 w. Engng—March 8, 1907. No. 83114 A.

Shops.

Shops of the New York Edison Company. Illustrates and describes some of the equipment of shops for central station repair work. 1800 w. Elec Wld—March 23, 1907. No. 83238.

Smoke.

The Influence of Central-Station Loads on Smoke Production. Dr. Charles E. Lucke. Gives data from two large stations in every-day operation, with a brief record of results which seem to indicate that continuous smokeless fuel combustion is impossible with rapid load fluctuations. 5000 w. Power—March, 1907. No. 82656 C.

Turbine Plant.

The New Steam Turbine Plant of the Potomac Electric Power Company, Washington, D. C. Illustrated description of a modern power plant of large size employing steam turbines as prime movers. 3000 w. Elec Rev, N Y—March 2, 1907. No. 82683.

Yellowstone.

Water Power Development in the Yellowstone Valley. G. A. Wheeler. Explains the conditions in this valley, showing that the question of water power resolves itself into low pressure plants of comparatively small output, and gives an illustrated description of such a plant. 2500 w. Sib Jour of Engng—March, 1907. Serial. 1st part. No. 83286 C.

Zambesi River.

Power Development of the Falls of the Zambesi River (L'Utilisation des Chutes du Zambèze). A description of the Victoria Falls and of the power developments which are to be made. 1400 w. L'Elec—Feb. 2, 1907. No. 82999 D.

LIGHTING.

Arc Lamps.

Flame Arc Lamps. H. S. Hatfield. Discusses the advantages of these lamps and illustrates and describes the design of Mr. Frank Lewis, its construction and control. 1800 w. Elect'n, Lond—March 15, 1907. No. 83268 A.

The Arc as a Source of Light. Elihu Thomson. Considers briefly the ways in which the electric flux known as an arc may produce light and the efficiency. 2500 w. Elec Rev, N Y—March 9, 1907. No. 82876.

History.

A History of Gas and Electric Lighting. M. E. Cornuault. Presidential address before the Société des Ingenieurs Civils de France. 4000 w. L'Elec—Feb. 2, 1907. No. 82998 D.

Illumination.

Light and Illumination. Charles P. Steinmetz. Read before the New York Section of the Ill. Engng. Soc. A study of the problems of effective illumination. 10,000 w. Pro Age—March 15, 1907. No. 83006.

Incandescent Lamps.

The New Types of Incandescent Lamps. A. Libesny. Abstract translation. Considers some of the newer types of lamps, and their increased efficiency, discussing the problems involved. 1800 w. Elect'n, Lond—March 1, 1907. No. 82895 A.

Electric Lighting by Incandescence. William J. Hammer. A review of the early work and the development, and the recent work with metallic filament lamps. 3500 w. Elec Rev, N Y—March 9, 1907. No. 82879.

Determination of the Average Horizontal Intensity of Incandescent Lamps (Uber die Bestimmung der mittleren Horizontal Lichtstärke von Glühlampen). F. Uppenborn. Discussion of different kinds of photometers and tabulation of the results of tests. Ills. Serial. 2 parts. 4800 w. Elektrotechnische Zeitschrift—Feb. 14 and 21, 1907. No. 82962 each B.

Mercury Vapor.

The Uviol Lamp. An illustrated description of a modification of the Hewitt mercury vapor lamp, for producing ultraviolet rays. 1000 w. Sci Am—March 9, 1907. No. 82809.

Projectors.

Improvements in Projectors. John I. Hall. Deals with the utilization of ordinary dispersion lenses of projectors to fulfil the requirements of the Suez Canal regulations, which stipulate that searchlights shall have a shadow in the center of 5° divergence. 1000 w. Elec Rev, Lond—March 1, 1907. Serial. 1st part. No. 82891 A.

Train-Lighting.

Train-Lighting. H. Henderson. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. The present number is largely a discussion of electric lighting for trains, and its advantages, cost, etc. Ills. 3000 w. Elec Engr, Lond—March 8, 1907. Serial. 1st part. No. 83108 A.

Tungsten.

The New Tungsten Lamps (Les nouvelles Laumes Electriques au Tungstene). M. Bainville. A discussion of the manufacture and practical value of the Tungsten filament lamp. Discussion. 3800 w. Bull Soc Int d Elecs—Feb., 1907. No. 82982 F.

MEASUREMENT.

Insulation.

Measurement of Wire and Cable Insulation. F. Wachter. Explains possible methods of obtaining the correct insulation resistance per mile of a certain wire or cable. 700 w. Elec Wld—March 23, 1907. No. 83240.

Meters.

Meter Testing. Oliver J. Bushnell. Considers the necessity of testing, the frequency, installation tests, and methods of testing. 3500 w. Can Elec News—March, 1907. No. 83194.

New Electricity Meter (Un Nuovo misuratore eléttrico). G. B. Picecco. Ills. 600 w. L'Elettricita—Jan. 18, 1907. No. 82901 D.

Pyrometry.

Optical Pyrometry. Gives an abstract of results of researches carried out by the Bureau of Standards of the United States Government. Ills. 6500 w. Engng—March 1, 1907. Serial. 1st part. No. 83000 A.

TRANSMISSION.

Direct Current.

The Transmission of Electrical Energy by Direct Current on the Series System. J. S. Highfield. Shows that M. Thury has carried the direct-current series system far beyond the experimental stage and has made great advancement in the improvement of direct-current generators and motors and in the use of very high pressures. Describes the system and gives information regarding cost. Ills. 9600 w. Inst of Elec Engrs—March 7, 1907. No. 83109 N.

High-Tension.

High-Tension Outlets. Alvin Meyers. An illustrated article describing work for the Telluride Power Co., tests carried out, and the design of bushing to meet stated requirements, giving specifications for constructing and installing 44,000-volt outlet bushings. 3800 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83046 D.

Hydro-Electric.

Electric Power Transmission. Frederick Darlington. A discussion of the qualities that chiefly affect the value of water powers, and the classes of loads to which they are applied, their development, etc. 2500 w. Pro Am Inst of Elec Engrs—Jan., 1907. No. 83025 D.

Long Distance.

Motor-Generators vs. Synchronous Converters, with Special Reference to Operation on Long-Distance Transmission Lines. P. M. Lincoln. A paper introductory to a discussion of this subject, making a comparison of reliability, voltage regulation, corrective effect, efficiency, cost, parallel operation and starting. 1000 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83049 D.

MISCELLANY.

"Energy Car."

"The Energy Car" ("L'Energy-Car"). H. Tudor and M. Braun. A truck fitted with gas engine, generator and battery of accumulators which is in reality a movable central station for small supplies of current. Ills. 3800 w. Soc Belge des Elecns—March, 1907. No. 82975 F.

Oil.

Drying Transformer Oil. R. B. Treat. Considers tests for determining moisture in oil and methods of removing it without harm to the oil. 1000 w. Elec Wld—March 2, 1907. No. 82774.

Protection.

Discussion on "Recent Investigation of Lightning Protective Apparatus" at New York, December 28, 1906. Discussion of R. P. Jackson's paper on this subject. 10800 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83048 D.

Review.

What Hath Been Wrought. William Hand Browne, Jr. A review of a quarter of a century's progress in the application of electricity, with portraits of men connected with the work. 7000 w. Elec Rev, N Y—March 9, 1907. No. 82875.

Transformer.

The De Faria Electrolytic Transformer (Transformateur Electrolytique, système O. de Faria). J. A. Montpellier. Description of an apparatus for transforming alternating into direct current on a small scale, especially adapted to laboratory use. Ill. 300 w. L'Elecn—March 2, 1907. No. 82980 D.

INDUSTRIAL ECONOMY

Accounting.

Brass Foundry Cost Accounting. D. Carl Eggleston. Outlines a system used. 1000 w. Foundry—March, 1907. No. 83182.

Channel Tunnel.

The Channel Tunnel. Translated from *L'Illustration.* Reviews the projects at various times for constructing a tunnel under the English Channel. 2000 w. Sci Am Sup—March 9, 1907. No. 82811.

Chemistry.

The Industrial Outlook for Physical Chemistry. Alfred Sang. Showing the important bearing of chemical research as applied to the industries. 6000 w. Pro Engrs' Soc of W Penn—Feb., 1907. No. 83036 D.

Coal Reserves.

How Long Will the Coal Reserves of the United States Last? Marius R. Campbell. Discusses the formation of coal, the production, distribution, estimated amount in the United States, etc. Also a short article on "Efforts to Obtain Greater Energy from Coal." 5000 w. Nat Geog Mag—Feb., 1907. No. 82661 C.

Cost Systems.

Cost Reduction Through Cost Comparison. C. E. Knoeppel. This second article of a series considers the treatment of machine, part, group, and operation costs. 1700 w. Engineering Magazine—April, 1907. No. 83315 B.

Labor: Premium System. F. E. Webner. The seventh of a series of articles on cost-keeping. 3300 w. Ir Trd Rev—March 7, 1907. No. 82787.

Education.

Engineering Education. Arthur J. Rowland. Some remarks on the proper scope of engineering education, particularly electrical engineering. 2000 w. Pro Am Inst of Elec Engrs—Jan., 1907. No. 83022 D.

Technical Foundry Education. H. E. Field. Read before the N. Eng. Found. Assn. Criticizes the methods taught and suggests a new course which will specialize in foundry practice. 3500 w. Foundry—March, 1907. No. 83176.

Technical Instruction in the United States (Instruction Industrielle Technique aux Etats-Unis d'Amérique). Dr. H. Schacht. The conclusions formed by Prussians who have investigated the subject. 6000 w. Rev Econ Inter—Feb., 1907. No. 82995 E + F.

German Technical Schools (Les Ecoles Techniques Allemandes). André Pelletan. Comprehensive account of the courses of study, laboratories, equipment, degrees conferred, etc. Tables and diagrams. 11,500 w. Bull De La Soc D'Encouragement Pour L'Ind Nat—Original Memoirs—Dec. 1, 1906. No. 82912 E + F.

The Marine Engineer, English and Foreign: His Training and Education. H. Bithel-Jones. Examines conditions existing in Germany, Denmark, Norway and Sweden, comparing with the conditions of British engineers. 5000 w. Marine Rev—March 7, 1907. No. 82814.

Engineering Laboratories of the University of Pennsylvania. An illustrated detailed description of these laboratories and their equipment. 9800 w. Ry & Engng Rev—March 23, 1907. No. 83250.

Gold Standard.

The Increased Production of Gold and Its Relation to the Standard of Value. Alexander E. Outerbridge, Jr. A discussion of the effect of the increased production of gold. Thinks the increase has failed to keep pace with the expansion of trade and increase in value of other products, and that there is no reason to fear its decline. 3000 w. Cassier's Mag—March, 1907. No. 83027 B.

Labor.

A Plan to Provide a Supply of Skilled Workmen. M. W. Alexander's paper on this subject is discussed. 5000 w. Pro Am Soc of Mech Engrs—March, 1907. No. 83169 C.

The Risks of the Trade. James P. Wilson. A discussion of the employer's liability law, especially in its relation to railway employees. General discussion. 10,000 w. Pro Ry Club of Pittsburgh—Jan., 1907. No. 83280 C.

The Utilization of Labor. Henry L. Gantt. A study of the economical utilization of labor. 5000 w. Stevens Ind—Jan., 1907. No. 83307 D.

Management.

Profit Making in Shop and Factory Management. C. U. Carpenter. This fourth article of a series shows the great importance and value of tool-room reorganization, suggesting methods for realizing the maximum possibilities of the tool-room. 3500 w. Engineering Magazine—April, 1907. No. 83313 B.

Packing.

Proper Packing. From the *Daily Consular and Trade Reports* of the Department of Commerce and Labor. Deals with the handling of machinery and parts for export. 3000 w. Ir Age—March 21, 1907. No. 83140.

Panama.

New York and Panama. A Contrast in Engineering Achievement. Ernest John Munby. An illustrated account of the extensive work connecting Manhattan with the mainland by numerous tunnels under the rivers, which is being executed under public contract, comparing it with the work at Panama. 4000 w. Engineering Magazine—April, 1907. No. 83310 B.

Shop Practice.

Modern Shop Practice from an Inspector's Standpoint. D. W. M'Naugher. Considers unskilled labor responsible for most of the troubles met. Discussion. 6000 w. Pro Engrs' Soc of W Penn—Feb., 1907. No. 83035 D.

South America.

An Awakened Continent to the South of Us. Elihu Root. An address before the Trans-Mississippi Commercial Congress, Kansas City, Missouri. A discussion of the steps needed to encourage the commerce and trade with South America. 7500 w. Nat Geog Mag—Jan., 1907. No. 83011 C.

U. S. Steel Co.

The United States Steel Corporation's Annual Report. Information of interest from this report, which shows the largest gross and net earnings in its history. 4000 w. Ir Age—March 21, 1907. No. 83142.

MARINE AND NAVAL ENGINEERING

Battleships.

Testing the New Battleship Vermont. An illustrated account of the severe trials made last December during stormy weather. Ills. 1500 w. Naut Gaz—March 7, 1907. No. 82844.

Boilers.

Combustion in Marine Boilers. Peter Youngson. An illustrated description of Howden's forced draught system, with introductory remarks. 3300 w. Marine Rev—March 7, 1907. No. 82812.

Combustion Motors.

Recent Progress in Internal-Combustion Motors for Marine Purposes (Recenti Progressi dei Motori Marini a Combustione Interna). I. D. Cardile. Ills. 15,000 w. Rivista Marittima—Feb., 1907. No. 82997 E + F.

Tendencies and Improvements in Marine Gas-Engine Construction. Howard Greene. Calls attention to progress and gives illustrated descriptions of recent engines modelled on an approach to steam-engine design. 3000 w. Engineering Magazine—April, 1907. No. 83314 B.

Cruiser.

The Trials of the German Turbine Cruiser "Lubeck." A report of the long series of trials to which this first turbine cruiser of the German Navy has been submitted. 1800 w. Engng—Feb. 22, 1907. No. 82837 A.

Docks.

Torpedo Boat Docks at the Kiel Imperial Ship Yard. Dr. Alfred Gradenwitz. Illustrated description of an interesting floating dock plant recently constructed for the docking of torpedo boats. 1200 w. Int Marine Engng—March, 1907. No. 82664 C.

Dry Dock.

New Dry Dock at Lorain. Improvements and extensions at the works of the American Shipbuilding Co. are illustrated and described. 1100 w. Marine Rev—March 7, 1907. No. 82813.

Electricity.

The Application of Electricity to Naval Service (Le Applicazioni dell' Elettricità ai Servizi Navali). E. Simion. A general review of the subject. 30000 w. Rivista Marittima—Feb., 1907. No. 82978 E + F.

German Navy.

The Real Facts About the German Navy. Archibald S. Hurd. An illustrated article giving a comparison between the naval strength of Germany and Great Britain. 5400 w. Cassier's Mag—March, 1907. No. 83026 B.

Lighthouse.

The Racine Reef Lighthouse and Fog Signal in Lake Michigan. Illustrated description of this lighthouse and its construction. 1500 w. Eng Rec—March 23, 1907. No. 83217.

Magnetism.

Polar Diagrams of Magnetic Deviation (Diagramma Polare Delle Deviazioni Magnetiche). E. Ippolito. Method of using a polar diagram for magnetic deviation to shorten navigation calculations. Diagrams and tables. 2900 w. Rivista Marittima—Dec., 1906. No. 82900 E + F.

Motor Boats.

The Motor Boat Show at Madison Square Garden. A. E. Potter. Review of the exhibits at this exhibition in New York City. 2000 w. Sci Am—March 2, 1907. No. 82643.

Naval Architecture.

The Dimensions, Proportions, and Forms of Ships. H. B. Donaldson. A discussion of the effect of different proportions on stability and the effect of consumable stores, and other conditions that may arise during service. Ills. 3000 w. Int Marine Engng—March, 1907. No. 82663 C.

Propulsion.

The Deformation of Propeller-Blades. William Burlingham. Discusses the best shape of section for a high-speed propeller-blade. Ills. 3000 w. Engng—March 1, 1907. No. 82897 A.

The Gasoline Motor in Shallow-Draft Vessels. An illustrated account of an experiment being carried out by the Thornycroft Company with shallow-draft vessels for freight service. 1000 w. Sci Am—March 30, 1907. No. 83296.

Sailing Vessels.

The Passing of American Square-Rigged Vessels. Discusses the causes that have led to the disappearance of this class of sailing vessels. Ills. 1500 w. Sci Am—March 9, 1907. No. 82807.

Salving.

How Compressed Air Raised a Sunken Ship. The Remarkable Salving of the Steamship "Bavarian." Illustrates and describes methods used in raising this vessel which was stranded near Quebec. 600 w. Sci Am—March 23, 1907. No. 83150.

Steel Steamer.

The Steel Freight Steamer Satilla. Illustrates and describes one of four freight steamers which have attracted interest on account of the arrangement adopted for the cargo spaces and the placing of the machinery. 700 w. Int Marine Engng—March, 1907. No. 82662 C.

Turbines.

The Marine Steam Turbine. J. W. Sothern. Discusses some of the points affecting the efficiency of steam turbines for the propulsion of ships. Diagrams. 2800 w. Naut Gaz—March 14, 1907. No. 83090.

Vibration.

Vibrations in Ships (Schiffsvibrationen). Walter Thele. Comparison of the vibrations set up in the engines of "Amerika," "Kaiserin Auguste Victoria" and "Deutschland." Illustrated by several diagrams. 2200 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 23, 1907. No. 82922 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Army Trains.

Electrically-Driven Target Trains in the German Army. Dr. Alfred Gradenwitz. Illustrations, with short description of trains moved by the Fowler steam traction engines. 800 w. Sci Am—March 2, 1907. No. 82645.

Articulation.

Experimental Investigation of a New Scheme of Articulation of Motor Vehicles. A. W. Brightmore. Discusses the possibilities of front driving, giving an account of investigations of steering for front-driving vehicles. Ills. 3000 w. Auto Jour—March 9, 1907. No. 83099 A.

Boilers.

Boilers for Steam Vehicles. F. Strickland. Brief illustrated descriptions of typical forms of boilers, with special consideration of boilers for steam vans. 3000 w. Auto Jour—March 9, 1907. No. 83100 A.

Britannia.

The 18-24 H.P. Britannia Car. Illustrates and describes details. 1300 w. Autocar—March 16, 1907. No. 83259 A.

Carburetters.

Float-Controlled Carburetters. — New and Old. Explains what happens in the carburetter and induction pipe of an engine at varying speeds, and gives illustrated description of the Gillett-Lehman device. 1700 w. Autocar—March 9, 1907. No. 83104 A.

Commercial Cars.

Coppock One-Ton Commercial Car. Illustrated description of a vehicle built at Marion, Ind. 1200 w. Automobile—Feb. 28, 1907. No. 82671.

Construction.

Limits of Tolerance in Automobile Parts. Thomas J. Fay. Discusses duplication of parts for automobiles, system necessary to meet requirements, metric measurements, etc. 2500 w. Automobile—March 28, 1907. No. 83302.

Cultivator.

A Steam Cultivator. Illustrated description of an interesting machine shown at the Milan exhibition. 500 w. Engr, Lond—March 8, 1907. No. 83121 A.

Exhibition.

Commercial Motor Vehicle Exhibition. Some of the exhibits at the recent exhibition at Olympia are illustrated and described. 5000 w. Engr, Lond—March 15, 1907. Serial. 1st part. No. 83272 A.

Ignition.

Sources of Electric Ignition Current. Charles B. Hayward. The present article considers the chemical and mechanical sources of current in a general way, to be followed by detailed articles on theory and practice. Ills. 3500 w. Automobile—Feb. 28, 1907. Serial. 1st part. No. 82669.

Light Cars.

The 8 H.P. Sizaire & Naudin Light Car. Illustrated detailed description of this car which attracted attention at the last Paris Salon. 1300 w. Autocar—Feb. 23, 1907. No. 82824 A.

Motor Plow.

The Castelin Automobile Plow. Describes a new system of plowing by the use of a gasoline motor and a special automobile. Ills. 600 w. Sci Am Sup—March 23, 1907. No. 83155.

Mud Shields.

Keeping the Mud Under Control. Translation from *La Vie Automobile,* giving the experience of a leading French body builder. Ills. 1000 w. Automobile—Feb. 28, 1907. No. 82670.

Omnibuses.

The Dennis Motor Vehicles. Illustrates and describes an interesting exhibit at the Olympia Show, a distinguishing feature being the drive by worm and worm-wheel. Also editorial. 3800 w. Engng—March 1, 1907. No. 82899 A.

The 40-45 H. P. Ryknield Motor 'Bus—An All-British Model. Illustrated detailed description of a petrol omnibus exhibited at Olympia. 1500 w. Auto Jour—March 9, 1907. No. 83098 A.

Orleans.

The British-Built Orleans Cars. Illustrated description of 35 h. p. 6-cylinder, and the 40 h. p., 4-cylinder cars. 1200 w. Auto Jour—March 2, 1907. Serial. 1st part. No. 82881 A.

Petrol-Electric.

The British Thomson-Houston Company's Petrol-Electric System for Commercial Vehicles. General remarks on petrol-electric systems, with illustrated description of Thomson-Houston system, which consists of a dynamo driven by a petrol engine, the whole of the engine power being converted by the dynamo into electrical energy, which is transmitted through a controller to two motors driving the road wheels. 2800 w. Elec Engr, Lond—March 8, 1907. No. 83107 A.

Renard Train.

The Renard Road Train. Illustrated description of this train of road vehicles, in which the power from the locomotive is transmitted by a shaft through the train so that each vehicle is independently driven. 800 w. Auto Jour—Feb. 23, 1907. Serial. 1st part. No. 82823 A.

Roydale.

The 18-22 H. P. Roydale Car. Illustrated description of a British car having new features. 2000 w. Autocar—March 2, 1907. No. 82883 A.

Steam Cars.

Steam Cars *versus* Petrol Cars at the A. C. G. B. I. A discussion opened by Frederic A. Coleman, in which he summarized the superior merits of external combustion. 3500 w. Auto Jour—March 9, 1907. No. 83101 A.

The 10-H. P. Bolsover Steam Car. A recently built low-power machine is illustrated and described. It is of the live-axle type. 2200 w. Auto Jour—March 16, 1907. No. 83258 A.

Timing.

Rudiments of Valve and Ignition Timing. Charles B. Hayward. Discusses the elementary requirements of timing, the factors to be considered, influence of valve design, etc. Diagrams. 3800 w. Automobile—March 21, 1907. No. 83193.

Two-Cycle.

A New French Recruit to the Two-Cycle. Translation from *L'Automobile.* Illustrated detailed description of the Dubois two-cycle motor. 1800 w. Automobile—March 28, 1907. No. 83303.

Tyres.

How to Make Vulcanized Tyre Repairs. Illustrates and describes the various means of effecting sound and satisfactory vulcanized repairs to tyre covers and air tubes. 2500 w. Autocar—March 9, 1907. Serial. 1st part. No. 83103 A.

War Cars.

Latest Designs of the Motor in Warfare. W. G. Fitz Gerald. Illustrates and describes recent designs in war automobiles, with comments on their use. 1200 w. Sci Am—March 23, 1907. No. 83149.

Zust.

The Züst 28-40 H. P. Chassis. Illustrated description of this Italian car, calling particular attention to the four-cylinder engine. 1200 w. Autocar—March 9, 1907. No. 83102 A.

COMBUSTION MOTORS.

Alcohol.

Denatured Alcohol. S. Lawrence Bigelow. An interesting article giving information in regard to alcohol, its manufacture, the properties of denaturants, uses of denatured alcohol, costs and prices. 10500 w. Pop Sci M—March, 1907. No. 82660 C.

Denatured Alcohol: Its Production and Uses. Arthur H. Bosworth. Considers the commercial sources of alcohol and the uses to which it may be applied. 3000 w. Yale Sci M—March, 1907. No. 83160 C.

Alcohol as Fuel for Farm Engines. Abstract of a report by the Special Commission, setting forth the conclusions from a series of tests of alcohol and gasoline in small internal combustion engines. 2500 w. Ir Age—Feb. 28, 1907. No. 82652.

Engine.

A New Vertical Internal Combustion Engine. Illustrations and short description of an engine recently patented in England. 700 w. Mech Engr—March 16, 1907. No. 83262 A.

Fuel.

Alkoethine, a Fuel for Gas Engines. Howard Greene. Describes the Barker-

White system, which consists in vaporizing alcohol in a carbureter of the ordinary gasoline type and passing the vapor, mixed with the proper volume of air, through calcium carbide. 1000 w. Ir Age—March 21, 1907. No. 83141.

An Alcohol-Acetylene Mixture for Internal-Combustion Engines. Illustrated description of an experimental testing plant for making all kinds of tests with a gasoline engine, with an account of the Barker-White system, where a mixture of acetylene gas and alcohol vapor is produced and used in the engine. 1500 w. Sci Am—March 23, 1907. No. 83148.

Kerosene Used in Gasoline Engines. An illustrated explanation of how changes from one fuel to the other may be made by the use of a common mixing valve or exhaust heated vaporizer. 1000 w. Engr, U S A—March 1, 1907. No. 82744 C.

Gas Analysis.

Gas Analysis with Home-made Pipettes. Harry Spurrier. Directions for making the apparatus, the materials required, and how to prepare it for use. Ills. 2500 w. Power—April, 1907. No. 83248 C.

Gas Engines.

Practical Data from Modern Gas Engines. L. L. Brewer. Information concerning fuel, water and oil consumption of representative types and their weight and space requirements. 2000 w. Power—April, 1907. No. 83245 C.

Gas, Gas Engines, and Gas Producers. J. Seton Gray. Points out the merits of the gas producer, comparing steam and producer plants. Ills. 4200 w. Can Soc of Civ Engrs—Feb. 28, 1907. No. 83032 N.

Gas Engine Troubles and How to Overcome Them (Schwierigkeiten im Betriebe der Gasmaschinen und ihre Beseitigung). Fritz Sellge. Describes valve and spark troubles and remedies for them. Ills. 4000 w. Stahl und Eisen—Feb. 13, 1907. No. 82952 D.

New Gas Engine Diagrams. Frank Foster. Describes the construction and use of a modified diagram for reciprocating gas-engine problems, and also a new temperature-pressure diagram for general gas engine problems. 2000 w. Engr, Lond—Feb. 22, 1907. No. 82838 A.

The Providence Gas Engines and Producers. Illustrated description of a horizontal gas engine adapted for operating on gases of low heat value, and of the suction gas producer. 1200 w. Ir Age—March 14, 1907. No. 83009.

Two New Gas Engines. Gives illustrated descriptions of a double-cylinder single-acting engine, and a four-cylinder vertical engine made in Manchester, England. 1000 w. Engr, Lond—Feb. 22, 1907. No. 82842 A.

Gas Turbines.

The Gas Turbine for Automobile Propulsion. W. H. Stuart-Garnett. A discussion of the problems to be solved in connection with combustion turbines, the progress made, and the possibilities of their application for the use named. 3000 w. Cassier's Mag—March, 1907. No. 83029 B.

Ignition.

Effect of Ignition on the Power of an Engine. W. Watson. Abstract of a paper read before the A. C. G. B. I. Gives a record of measurements made by the writer. 1700 w. Auto Jour—March 2, 1907. No. 82882 A.

High-Tension Electric Ignition for Petrol Engines. John A. Davenport. A report of a series of experiments carried out at East London College laboratory, giving results and describing apparatus. 2000 w. Engng—Feb. 22, 1907. No. 82833 A.

Manograph.

The Schultze Manograph for Taking Indicator Cards of Gasoline Engines. Illustrated description of an instrument designed to give an accurate diagram of the pressure obtained in the cylinder of an internal-combustion engine. 1200 w. Sci Am Sup—March 23, 1907. No. 83156.

HEATING AND COOLING.

Cooling Towers.

Cooling Towers. B. Franklin Hart, Jr. Read before the Am. Soc. of Refrig. Engrs. Describes the use of the cooling tower in a refrigerating or ice-making plant and its advantages. Ills. 1500 w. Stevens Ind—Jan., 1907. No. 83309 D.

Furnace Heating.

Proper Heater Location and Duct Area Exemplified. John P. Bird. Illustrated description of a furnace heating system with branching cellar mains and oval flues. Also editorial. 1400 w. Met Work—March 16, 1907. No. 83051.

Heaters.

Heaters for Hot Blast and Ventilation. Charles L. Hubbard. Illustrated descriptions of types of heaters, discussing their efficiency, etc. 2500 w. Mach, N Y—March, 1907. No. 82765 C.

Ice Plant.

Operating an Absorption Machine. William S. Luckenbach. Gives practical details in the operation of an absorption ice plant. 3000 w. Engr, U S A—March 1, 1907. No. 82745 C.

Pipes.

Standardization of Cast-Iron Heating and Ventilating Pipes. Louis F. Pearson. From a paper before the British Inst. of Heat. & Vent. Engrs. An account of the work done by the committee appointed to consider cast pipes. 2200 w. Heat & Vent Mag—March, 1907. No. 83173.

Refrigeration.

The Commercial Application of Refrigeration. Hal Williams. Showing the large field developed for the application of refrigeration in the industries. General discussion. 8500 w. Jour Soc of Arts—Feb. 22, 1907. No. 82820 A.

Refrigeration on Shipboard. Joseph H. Hart. Reviews briefly the types and methods of refrigerating machines, their efficiency, operation, etc. 3000 w. Cassier's Mag—March, 1907. No. 83031 B.

Absorption Refrigerating Machines. James W. Cooper. Diagrammatic elevation and explanation of how a plant is laid out, giving practical directions for running either a dry or a brine system. 2500 w. Power—April, 1907. No. 83247 C.

Typical Representation of Work and Change of State of the Refrigerant in All Parts of a Compression Machine (Bildliche Darstellung der Arbeitsvorgänge und Zustandsänderung des Kältemittels in allen Teilen der Kompressions-Kältemaschine). Gustav Döderlein. Action of such machines shown and discussed by indicator diagrams. Diagrams. 1700 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 16, 1907. No. 82933 D.

Ventilation.

A Notable Jersey Schoolhouse Ventilating Plant. The heating and ventilating system installed in the Ashland School, in East Orange, N. J., is illustrated and described. Indirect heating from Kinnear radiation and from steam boiler setting. Ventilated by gravity or by fans. 2500 w. Met Work—March 2, 1907. No. 82676.

Ventilation of Office Buildings (Uber Lüftungseinrichtungen in Amtsgebäuben). Leopold Nowotny. Consideration of the size of air openings required. Diagram. 1800 w. Oest Wochenschrift f d Oeffentlichen Baudienst — Jan. 26, 1907. No. 82934 D.

The Ventilation of the House of Commons. Walter Yates. Slightly abridged paper read before the Heat. & Vent. Engrs. of Gt. Britain. Plans and description of methods now employed, with brief account of earlier methods. 3500 w. Met Work—March 30, 1907. Serial. 1st part. No. 83318.

HYDRAULICS.

Energy.

The Kinetic Energy of Flowing Water. L. F. Harza. A mathematical investigation made to determine about what degree of dependence can be placed on the value of the energy as usually determined, and whether more accurate methods are worth while. 600 w. Eng News—March 7, 1907. No. 82800.

Pumps.

Centrifugal Pumps. Henry F. Schmidt. Remarks on recent improvements in these pumps, with reasons why the writer thinks they will soon replace the plunger pump where the volume of water to be handled is large enough so that a high efficiency can be obtained. Ills. 2000 w. Power—March, 1907. No. 82659 C.

Practical Efficiency of Centrifugal Pumps (Wirkungsgrade von Zentrifugalpumpen). E. Kux. Discussion of the question on the basis of actual tests. Diagrams. Serial. 2 parts. 2100 w. Zeitschrift für das Gesamte Turbinenwesen—Feb. 28, and March 9, 1907. No. 82946 each D.

Electric Pumps. D. Penman. Describes the high-speed turbine pump, and the electric three-throw pump. 1200 w. Min Rept—Feb. 28, 1907. No. 82749.

The Hydraulic Ram (Der hydraulische Widder). ——— Zink. Description of leading European types, and calculations of the effects produced. Ills. 4400 w. Oest Wochenschrift f d Oeffentlichen Baudienst—Feb. 2, 1907. No. 82931 D.

Stream Lines.

Stream Lines and Their Application to Engineering Purposes. Dr. H. S. Hele-Shaw. Abstract of a paper read before the Jr. Inst. of Engrs. Explains the method of investigation and gives practical examples of its application to engineering problems. 2800 w. Mech Engr—March 2, 1907. No. 82890 A.

Turbines.

New Theory of Turbines (Zur neuen Theorie der Kreiselräder). H. Lorenz. Mathematical treatment; one diagram. 4800 w. Zeitschrift für das Gesamte Turbinenwesen—Feb. 9, 1907. No. 82942 D.

Remarks Upon the Practical Application of Lorenz' Theory and Discussion of the Water Flow in Centrifugal Pumps (Bemerkungen über die praktische Verwendbarkeit der Lorenzschen Turbinentheorie und Vorschläge zur Klarstellung der Wasserbewegung in Kreiselrädern). Viktor Kaplan. Diagram. 1800 w. Zeitschrift für das Gesamte Turbinenwesen—Feb. 20, 1907. No. 82944 D.

Reply to Dr. Lorenz' Essay on a New Theory of Turbines (Erwiderung auf die Abhandlung von Prof. Dr. Lorenz, etc.). F. Prasil. Mathematical treatment and discussion of article 82942. 3200 w. Zeitschrift für das Gesamte Turbinenwesen—Feb. 20, 1907. No. 82943 D.

New Theory of Turbines: Part II. Answers to Kaplan's and Prasil's Criticisms (Zur neuen Theorie der Kreiselräder II. Autwort auf die Einwürfe der Herren Kaplan und Prasil). H. Lorenz. Replies to objections to the Lorenz theory. Diagrams. 4400 w. Zeitschrift für das Gesamte Turbinenwesen—Feb. 28, 1907. No. 82945 D.

Exposition of the Advantages of Turbines and Centrifugal Pumps (Eine Veranschaulichung der Vorgänge in den Turbinen und Kreisel pumpen). Egon Eickhoff. Ills. 1600 w. Conclusion of serial. Zeitschrift für das Gesamte Turbinenwesen—Jan. 30, 1907. No. 82941 D.

MACHINE WORKS AND FOUNDRIES.

Boilers.

Calculating Butt-Strapped Boiler Seams. J. E. Werman. Explains a shortened method of determining relative superiority of inner and outer sections. Ills. 900 w. Power—March, 1907. No. 82653 C.

Calipering.

Calipers and the Art of Calipering. Frank A. Stanley. A collection of selected articles dealing with various phases of this subject, with many illustrations. 28500 w. Am Mach—Vol. 30, No. 10. No. 82794.

Castings.

The Characteristics of Foundry Iron. George Hailstone. Gives a résumé of its micro-constituents, discussing the results of mixtures of different grades and the causes of defective castings. Ills. 4500 w. Foundry—March, 1907. No. 83179.

Overcoming Difficulties in Casting Manganese Bronze. A. B. Brown. An illustrated account of the writer's experience, and final success. 3000 w. Brass Wld—March, 1907. No. 83281.

Molding a Large Jig Casting. Jabez Nall. Illustrates and describes the method of molding entirely in cores. 1000 w. Am Mach—Vol. 30, No. 12. No. 83145.

A Peculiar Chilled Casting. George C. Davis. Describes a casting presenting unusual features. 1000 w. Foundry—March, 1907. No. 83178.

Cores.

Time Lost in the Core Room. Jabez Nall. Discusses the making of a core-box for a four-step cone pulley, and other cores. Ills. 1600 w. Foundry—March, 1907. No. 83181.

Improved Method of Turning Valve Cores. James R. Kelly. Describes a method of arrangement which enables ten or twelve valves to be molded in the same size flask previously filled by four to six. Ills. 500 w. Foundry—March, 1907. No. 83177.

Cupola.

Construction and Management of the Cupola Furnace (Bau und Betrieb der Kupolöfen). C. H. Jaeger. Enumeration of the leading factors controlling the design of such furnaces. 2200 w. Stahl und Eisen—March 6, 1907. No. 82949 D.

Cutting Metals.

The Art of Cutting Metals. Discussion of the paper on this subject by F. W. Taylor. 10,000 w. Pro Am Soc of Mech Engrs—March, 1907. No. 83167 C.

Dies.

A Built-up Blanking Die That Will Keep Its Size. Julius F. A. Vogt. Sketch, with description of how they were made. 600 w. Am Mach—Vol. 30, No. 12. No. 83143.

Roughing and Finishing Spring Screw Dies. Erik Oberg. Gives method of calculating the amount of material to be removed, and the diameter of the roughing die. 800 w. Mach, N Y—March, 1907. No. 82769 C.

The Construction of Split Dies for Press Work. C. F. Emerson. Illustrates and describes methods. 1000 w. Mach, N Y—March, 1907. No. 82770 C.

Drilling.

The Work of Machine Tools (Expèriences sur le Travail des Machines-Outils). C. Codron. Results of experiments on the power required for drilling various metals and alloys. Ills. 8500 w. Rev de Mécan—Feb. 28, 1907. No. 82972 E + F.

Flywheels.

A High Efficiency Fly-Wheel Joint. Illustrates and describes Haight's fly-wheel joint, giving the highest commendation of the construction. 1400 w. Am Mach—Vol. 30, No. 9. No. 82665.

Foundry.

A Modern Grey Iron Foundry. Illustrated description of plant at Barberton, O., calling attention to novel features, and a few unique molding methods. 2200 w. Foundry—March, 1907. No. 83175.

Gears.

Gear Ratios for Motor Drives. W. Owen. Gives a table of gear changes for motor drives, explaining its use. 600 w. Am Mach—Vol. 30, No. 13. No. 83305.

Gearing.

The Mechanism of Power Transmission from Electric Motors. Wilfred L. Spence. Presents possible alternatives to the commoner methods, showing illustrations of good and bad practice, and also typical applications of each system. 9000 w. Trans Inst of Engrs & Shipbldrs in Scotland—Feb. 19, 1907. No. 83300 N.

Hammer.

108-Ton Pneumatic Hammer. A brief account of the Terni Steel Works, in Italy, with an illustrated description of this hammer and its operation. 1500 w. Engr, Lond—March 8, 1907. No. 83123 A.

Hardening.

Use of the Lead Pot in Hardening—Cyanide Solution. E. R. Markham. Suggestions of value in heating steel for hardening, and the treatment to secure good results. 1000 w. Am Mach—Vol. 30, No. 9. No. 82666.

Lathe.

A New Pratt & Whitney Lathe. Illustrated description of this new 16-in. engine lathe recently brought out. It is intended for tool-room use and for high-class manufacturing. 2500 w. Ir Age—Feb. 28, 1907. No. 82650.

Purchasing a Lathe. W. T. Sears. The importance of knowing what work the lathe is to do, the treatment it is likely to receive, etc. 1400 w. Am Mach—Vol. 30, No. 13. No. 83304.

Machine Foundations.

A Modern Foundation for Heavy Tools. Illustrated description of the system of putting in foundations for heavy tools, used by Norton Grinding Co., of Worcester, Mass. 700 w. Am Mach—Vol. 30, No. 10. No. 82793.

Machine Tools.

Machine Tools at the Nuremberg Exposition (Die Werkzeugmaschinen auf der Bayerischen Jubiläums-Landesausstellung, Nürnberg, 1906). G. Schlesinger. Description of shop tools, belt and motor driven, shown at Nuremberg. Ills. 1400 w. Continuation of serial. Zeitschr d Ver Deutscher Ing—Feb. 2, 1907. No. 82918 D.

Machining.

Machining Time-recorder Frames. Edward Snyder. Illustrating and describing the profiling and milling fixtures used and details of setting, supporting and clamping the work. 1500 w. Am Mach—Vol. 30, No. 12. No. 83146.

Molding Machines.

Modern Equipment in Old Plants. H. M. Lane. An illustrated account of molding machine development in a foundry at Cuyahoga Falls, Ohio. 2800 w. Ir Age—March 14, 1907. No. 83010.

Patterns.

Segment Works. H. N. Tuttle. Discusses a few schemes which are often used. Diagrams. 4300 w. Foundry—March, 1907. No. 83180.

Shops.

The New Locomotive Erecting Shop at Darlington Works, North-Eastern Ry. Charles S. Lake. Illustrated detailed description. 1400 w. Eng Rec—March 23, 1907. No. 83221.

The Works of the Union Twist Drill Company. Illustrated description of a plant equipped for the manufacture of gear cutters, milling cutters, etc., with facilities for machining, hardening and testing. 4000 w. Am Mach—Vol. 30, No. 10. No. 82791.

The Armstrong Pozzuoli Works. Illustrates and describes these important works, near Naples, Italy, for the manufacture of war material of all kinds. Plate. 1200 w. Engr, Lond—March 15, 1907. No. 83271 A.

Signals.

Factory Intercommunication Systems. John Drummond. An explanation of the electric light signals as used by the Cleveland Twist Drill Company. 2500 w. Ir Age—March 7, 1907. No. 82790.

Slide Valve.

Study of the D Slide Valve. E. S. Hawkins. A study of the practical working of the Zeuner diagram, giving examples with solutions. 3000 w. Power—March, 1907. No. 82657 C.

Soldering.

The Autogenous Soldering of Metals. M. U. Schoop. An illustrated article on the processes for carrying out autogenous soldering, and its wide utilization. 2500 w. Sci Am—March 2, 1907. No. 82642.

Tools.

The Making of High-Speed Steel Tools. O. M. Becker. Describes how these tools should be heated for forging and tempering and the apparatus advisable to use. Ills. 4500 w. Am Mach—Vol. 30, No. 12. No. 83144.

Helpful Hints for the Toolmaker. F. E. Shailor. Hints on cutting a smooth thread, hardening, cutting cams accurately, dies, etc. Ills. 1500 w. Mach, N Y—March, 1907. No. 82768 C.

A Useful Combination Tool. A. Frederick Collins. Illustrates and describes a tool combining on a single base, a pipe vise, an anvil, a forge, bench vise, drill press and emery wheel. 800 w. Sci Am—March 2, 1907. No. 82641.

Special Tools for Musical Instrument Work. S. J. Putnam. Illustrates and describes special tools and their making and use. 2000 w. Mach, N Y—March, 1907. No. 82767 C.

Vibrations.

Mill Vibrations. Eugene B. Whipple. Describes the nature and cause of some of these vibrations, and presents methods that have been employed in stopping them. 1500 w. Jour Worcester Poly Inst—March, 1907. Serial. 1st part. No. 83278 C.

Welding.

Methods and Costs of Electrically Welding 3,087 Girder Rail Joints at Camden, N. J. P. Ney Wilson. A report of the organization and cost of this work. 3000 w. Engng-Con—March 20, 1907. No. 83126.

Autogenous Welding With the Oxy-Acetylene High-Pressure Blowpipe. Illustrates and describes this system, which has recently been perfected by a London company. 1000 w. Sci Am—March 23, 1907. No. 83153.

Wire.

History of Wire Drawing (Geschichtliches von der Drahtzieherei). B. Neumann. 1600 w. Stahl und Eisen—Feb. 20, 1907. No. 82954 D.

MATERIALS OF CONSTRUCTION.

Alloys.

Note on Alloys of Aluminum (Contribution à l'Etude des Alliages de l'Aluminium). Hector Pécheux. Results of investigations on the physical, electrical and chemical properties of aluminium and the more fusible metals, lead, tin, zinc, bismuth, etc. 4700 w. Rev Gen des Sci—Feb. 15, 1907. No. 82994 D.

Disintegration of Aluminum Alloys. Erwin S. Sperry. Gives illustrated examples of disintegration of half and half alloys. 500 w. Brass Wld—March, 1907. No. 83285.

Alloys of Manganese and Copper (Alliages De Manganèse De Cuivre). S. Wologdine. Review of some of these alloys, fusing points, micro-photographs, etc. Ills. 4600 w. Revue de Métallurgie—Jan., 1907. No. 82909 E + F.

Alloy Steel.

A Crucial Test of Modern Alloy Steel. Thomas J. Fay. An account of the condition of material, after a serious automobile accident while the car was traveling a mile a minute. Ills. 1800 w. Automobile—Feb. 28, 1907. No. 82668.

Nickel-Silicon Steels (Aciers Nickel-Silicium) M. L. Guillet. Study of the properties of steel with different proportions of nickel and silicon. Ills. 6500 w. Bull de la Soc D'Encouragement Pour L'Ind Nat—Original Memoirs—Dec., 1906. No. 82911 E + F.

Chrome Tungsten Steel (Aciers Chrome-Tungstène). M. L. Guillet. A study of steels by their microstructure. Ills. 6000 w. Revue De Métallurgie—Jan., 1907. No. 82908 E + F.

Nuts.

Note on the Working Loose of Nuts. André Minne. Discusses the ordinary lock-nut and describes an improved lock-nut. 1200 w. Bul Int Ry Cong—Feb., 1907. No. 83291 E.

Rails.

Open Hearth Steel Rails. Benjamin Talbot. Discusses the reasons for their displacement of the Bessemer product. 3300 w. Ir Age—Feb. 28, 1907. No. 82651.

Steels.

Steels Used on Automobile Construction. E. F. Lake. Gives analyses and physical characteristics of carbon chrome nickel steels and other high-class materials used in making frames, gears, etc. Ills. 5500 w. Am Mach—Vol. 30, No. 11. No. 83013.

MEASUREMENT.

Dynamometers.

On Some Forms of Rotative Output Dynamometers. W. W. F. Pullen. The present article deals with the absorption, or output dynamometers, the difficulties of their operation and the methods of surmounting them. Ills. 2800 w. Mech Engr—Feb. 23, 1907. Serial. 1st part. No. 82825 A.

Indicator Cards.

Reading Two-Stage Air-Compressor-Indicator Cards. Frank Richards. An explanation, with cards from a compressor tested. 1600 w. Power—April, 1907. No. 83242 C.

Metric System.

Our Present Weights and Measures and the Metric System. Discussion of paper by Henry R. Tame on this subject. 5800 w. Pro Am Soc of Mech Engrs—March, 1907. No. 83168 C.

POWER AND TRANSMISSION.

Air Compressors.

Some Important Elements of Economy in the Straight Line and Duplex Types of Compound Air Compressors. Lucius I. Wightman. Explains the advantages of compounding the relation of power to resistance in each type, losses, etc. Ills. 2000 w. Compressed Air—March, 1907. Serial. 1st part. No. 83301.

Sectionalized Air Compressors. Frank Richards. An illustrated article discussing sectionalized machines, their advantages and disadvantages. 1000 w. Am Mach—Vol. 30, No. 10. No. 82792.

The Flickinger Gas Driven Air Compressor. Illustrated detailed description of a combination of a gas engine and air compressor. 1200 w. Ir Age—March 7, 1907. No. 82789.

A Hydraulic Air-Compressing Plant. Illustrated description of the plant at the Victoria mine in the northern part of Michigan. A column of water sucks down the air which is trapped in a chamber and used for driving pneumatic machinery. 1200 w. Sci Am—March 16, 1907. No. 83018.

Some Features of Air Compression. C. A. Dawley. Reviews the development of air compressors, discussing the factors affecting the economy, the losses, and related subjects. 1100 w. Sib Jour of Engng—March, 1907. No. 83287 C.

Cranes.

150-Ton Hydraulic Wharf-Crane at Elswick. Illustrations, with brief description of a crane for putting heavy loads on board ships. 300 w. Engng—Feb. 22, 1907. No. 82836 A.

Electric Drive.

Advantages and Applications of the Electric Drive. F. B. Crocker and M. Arendt. Portion of lecture notes from the Electrical Engineering Department of Columbia University, with illustrations of various applications. 1600 w. Sci Am Sup—March 2, 1907. No. 82647.

Elevators.

Electrically-Driven Hydraulic Lifts. Illustrated description of the Boddam system of combining the electrical drive with an existing hydraulic lift. 1200 w. Elec Engr, Lond — March 15, 1907. No. 83263 A.

High-Pressure Elevator Equipment of the Metropolitan Life Insurance Building, New York. Illustrated detailed description of the elevator plant for an unusually large building and extensive elevator service. 3500 w. Eng Rec—March 23, 1907. No. 83212.

Fuel Handling.

Coal Storage and Coal Conveying Systems. Franz Koester. Illustrates and describes some of the modern methods employed in handling fuel for large power stations at home and abroad. 3800 w. Power—April, 1907. No. 83244 C.

Gear Wheels.

Loss of Power by Transmission with Geared Wheels. John Batey. A study of the frictional resistance of toothed gear drives. 2300 w. Prac Engr—March 1, 1907. No. 82884 A.

Power Plants.

Hydro-Electric Power versus Steam for Industrial Plants. H. von Shon. Gives a comparison of availibility, efficiency and cost, and reviews the development of water power into electric energy. 5500 w. Engineering Magazine—April, 1907. No. 83312 B.

Power Plant of the Quintard Iron Works Company of New York City. Illustrated detailed description of the power plant for shops manufacturing heavy and light machine work, engines, boilers, large condensers, pumps, etc., etc. Electric power. steam and compressed air are used. 5000 w. Elec Rec, N Y—March 16, 1907. No. 83064.

Ravenna Plant of the Cleveland Mills Co. Illustrated description of a plant that supplies electric power for lighting and for driving machinery, and steam for various uses connected with the manufacture of worsteds. 2500 w. Engr, U S A—March 1, 1907. No. 82741 C.

Power Plants for Private Commercial Establishments (Grossstädtische Kraftwerke für Privatbetriebe). E. Josse. Description of some large independent plants for factories in Germany. Ills. Serial. 3 parts. 11000 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 16 and 23, and March 2, 1907. No. 82928 each D

Ropes.

The Splicing of Fibrous Ropes. V. C. Vance. Instructions, with illustrations. 1200 w. Engr, U S A—March 15, 1907. No 83093 C.

Shaft Hangers.

Attaching Fixtures to Concrete. L. P. Alford. Illustrates and describes devices worked out for a plant at Beverly, Mass. 1800 w. Am Mach—Vol. 30, No. 11. No. 83012.

Storage Batteries.

Hints on the Practical Management of the Storage Battery—Precautions Necessary in Charging and Discharging End Cells. William Kavanagh. Information, with illustrations. 1400 w. Power—March, 1907. No. 82658 C.

Storage Battery Economy in Railway Power Plants. Arthur C. Scott. Discusses the conditions warranting the installation of a battery. Ills. 1800 w. Engr, U S A—March 1, 1907. No. 82742 C.

STEAM ENGINEERING.

Boilers.

Effect of Water on the Life of Boilers. A. S. Atkinson. Discusses the effect of feed-water, loss of efficiency due to scale, the effect of sulphuric acid and acid iron salts, and methods of removing dangerous elements from the feed water before it enters the boiler. 2200 w. Boiler Maker—March, 1907. No. 82677.

Watching a Boiler at Work—An Account of Experiments with a Glass Model of a Water-tube Boiler. C. Hill Smith. Ill. 2300 w. Power—April, 1907. No. 83246 C.

Clearance.

The Compression of Steam in the Clearance Space of Engines (Expériences sur la Compression de la Vapeur dans l'Espace Nuisible des Machines à Vapeur). J. Boulvin. Gives the results of elaborate experiments on a single-cylinder, non-condensing engine using saturated steam. Ills. 10000 w. Rev de Mécan—Feb. 28, 1907. No. 82973 E + F.

Condensers.

Condensers and Condensing Plants. Illustrates and describes types of jet condensers and of surface condensing plants. 2200 w. Mech Engr—March 9, 1907. Serial. 1st part. No. 83106 A.

Engines.

The Proper Management of Corliss Engines. W. H. Wakeman. An illustrated article treating especially of the adjustment of the valve gear and how to avoid mistakes often made by engineers. 2200 w. Power—April, 1907. No. 83241 C.

Shop Talk About Steam Engines. C. W. Crawford. A comparison of the clearance and leakage losses in the various types of poppet valve, slide valve, and Corliss engines. 2500 w. Am Mach—Vol. 30, No. 13. No. 83306.

Trials of Engineers in the Early Days. Alonzo G. Collins. Gives results of research in England for engine types of the time of Newcomen and Watt. Ills. 3000

w. Power—April, 1907. Serial. 1st part. No. 83243 C.

Types of Early Steam Engines Still Working in England. Information relating to a few plants installed over one hundred years ago, and still working. 1600 w. Sci Am Sup—March 2, 1907. No. 82649.

Firing.

Instructions to Govern the Use of Coke on Locomotives. Instructions issued by J. E. Muhlfeld, of the B. & O. R. R. to govern the use of coke on the locomotives of that road. 1200 w. Am Eng & R R Jour—March, 1907. No. 82781 C.

Fuels.

Fuels for Steam Making. R. T. Strohm. Considers the heat-producing elements in fuels, the constituents, the requirements of good steam producing fuels, and related matters. 2500 w. Elec Wld—March 2, 1907. No. 82777.

Governors.

Shaft Governors. C. F. Swingle. General remarks, with descriptions of Poncelot's governor, Siemens' governor, and the Fitchburg shaft governor. Ills. 2200 w. Engr, U S A—March 1, 1907. No. 82743 C.

Mechanical Draft.

The Application of Mechanical Draft to Stationary Boilers. Walter B. Snow. Presents the advantages of mechanical draft, and discusses the cost. 3500 w. Cal Jour of Tech—March, 1907. No. 83190.

Oil Fuel.

Commercial Aspects of Oil as Fuel for Power Generation. Franz Erich Junge. Considered in competition with other combustibles used in the generation of power, with remarks on its value and quantity of production and general characteristics. 4000 w. Power — March, 1907. No. 82654 C.

Regulators.

The Regulation of Boiler Feeders. Charles S. Towne. Illustrates several applications of regulators to boilers, and discusses when it will pay to install them. 2000 w. Elec Wld—March 2, 1907. Serial. 1st part. No. 82778.

Superheating.

The Specific Heat of Superheated Steam. Discusses results of recent experiments. 1500 w. Engng—Feb. 22, 1907. No. 82832 A.

Present Practice in the Use of Superheated Steam. Reginald Pelham Bolton. Discusses American practice and applications, the advantages, limitations, etc. 3000 w. Engineering Magazine — April, 1907. No. 83316 B.

Thermodynamics.

The Dynamics of Steam in Piston Engines (Zur Dynamik der Dampfströmung in der Kolbendampfmaschine). W. Schüle and Otto Schneider. Mathematical treatment. Diagrams. 2200 w. Zeitschrift des Vereins Deutscher Ingenieure—Feb. 9, 1907. No. 82924 D.

Turbines.

Notes on Turbine Troubles. G. Nevil-Thomas. Calls attention to some troubles met with in the writer's experience. 1000 w. Elec Rev, Lond—Feb. 22, 1907. No. 82827 A.

The Kerr Steam Turbine. C. V. Kerr. Illustrated description of a turbine built on the principle of the Pelton water wheel. It is a nozzle and bucket turbine of the impulse type. 3000 w. Power—March, 1907. No. 82655 C.

Steam Turbines and Their Use in Electric Railway Power Plants (Die Dampfturbinen und ihre Anwendung auf den elektrischen Bahnbetrieb). Guido Semenza. Comparison between the leading types and examples of their use in Europe. 5900 w. Serial. 3 parts. Zeitschrift für das Gesamte Turbinwesen—Jan. 30, Feb. 9 and Feb. 20, 1907. No. 82940 each D.

Valve Gear.

Adjusting Stephenson Valve Gear. James Kennedy. Detailed directions for the adjustment with related information. Ills. 2500 w. Ry & Loc Engng—March, 1907. No. 82700 C.

Single-Eccentric Meyer Valve Gear. H. V. Haight. Drawings and description of a valve gear in which both main and cut-off valves are driven from a single eccentric. 500 w. Am Mach—Vol. 30, No. 9. No. 82667.

Water Softening.

The Present Status of the Art of Water Softening. Explains why hard water is unsatisfactory in the industries, and the principles of water softening and its practice, illustrating many plants. 4800 w. Cassier's Mag—March, 1907. No. 83030 B.

Water-Tubes.

Tempersley-Cockburn System of Steam Extraction for Water-Tube Boilers. Illustrated description, with report of trials made with boilers of the Belleville type. 2500 w. Mech Engr—March 2, 1907. No. 82888 A.

MISCELLANY.

Aeronautics.

An Interesting German Flying Machine. Dr. Alfred Gradenwitz. The machine developed by J. Hofman, of Berlin, is illustrated and described. 1500 w. Sci Am—March 23, 1907. No. 83152.

New French Aeroplanes. Illustrates and describes Santos Dumont's new aeroplane, and M. Delagrange's aeroplane. 1500 w. Sci Am—March 30, 1907. No. 83297.

Metal Evaporation.

The Evaporation of Solid Metals and Their Compounds. Describes method of demonstrating. 1000 w. Sci Am—Apr. 6, 1907. No. 83455.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Falls of Roof and Coal. Recommendations of the Prussian Commission with a view to prevent accidents. 1200 w. Min Wld—March 2, 1907. No. 82757.

Coal-Cutting.

Electrical Coal-Cutting by Bar Machines, with Special Reference to the "Simplex" Machine. Arthur Hall. Read before the Nat. Assn. of Col. Mgrs. The discussion is confined to bar machines, stating their advantages over disc machines, and illustrating and describing the Goolden machine and "Simplex" and the "Hurd." 8000 w. Ir & Coal Trds Rev—March 1, 1907. No. 83005 A.

Coal Dust.

The Coal Dust Problem. James Ashworth. Gives quotations from the report of W. N. Atkinson, Henry Hall, and Dr. J. S. Haldane on their recent visit to the Westphalian coalfield, with discussion of the question. 4500 w. Engr, Lond—March 15, 1907. No. 83270 A.

Coal Fields.

The Hidden Coal Fields of the Midlands. Prof. C. Lapworth. Abstract of a paper before the S. Staffordshire & Warwickshire Inst. of Min. Engrs. Describes the geology of this region, and gives the conclusions from facts based on research, discussing the prospect of production from the commercial point of view. 4000 w. Min Jour—Feb. 23, 1907. No. 82830 A.

The Discovery of the South-Eastern Coal Field. Prof. W. Boyd Dawkins. An account of the discovery of this new coalfield in England, tracing the gradual verification of Godwin-Austen's theory by a series of experiments, and furnishing a striking instance of the value of scientific research. General discussion. Ill. 6500 w. Jour Soc of Arts—March 8, 1907. No. 83095 A.

Coke.

Manufacture of Coke from Western Coal. R. S. Moss. Shows the difference between eastern and western coals, and claims that coke can be made from western coals if work is carried out on established principles. 1200 w. Min Wld—March 16, 1907. No. 83088.

Coke Supply.

The Connellsville Coke Supply. L. W. Fogg. Deals with the coal areas and coke supply of Fayette and Westmoreland counties, Pennsylvania. 1200 w. Ir Age—March 28, 1907. No. 83294.

Electricity.

Use of Electricity in Anthracite Mining. H. M. Warren. Illustrates and describes the equipment of the Woodward mines at Kingston, Penn., an example of an isolated direct-current station. 800 w. Eng & Min Jour—March 2, 1907. No. 82692.

Electrically Driven Colliery Pumps. Alfred Gradenwitz. Illustrated description of the electric pumping installation at the Concorde collieries, Belgium. 1200 w. Eng & Min Jour—March 9, 1907. No. 82819.

Gases.

Coal Mine Gases and Barometric Pressure. Floyd W. Parsons. Observations on the possibility of concurrent action on the part of mine gases and fluctuations in atmospheric pressure. 1800 w. Eng & Min Jour—March 2, 1907. No. 82691.

Haulage.

Electric Power vs. Mules for Mine Haulage. M. B. Peltier. Illustrated description of the electric installation at the No. 3 mine of the Peabody Coal Co. in Illinois. Shows an increase in output, and effects a saving of one cent per ton. 1200 w. Eng & Min Jour—March 16, 1907. No. 83078.

Indiana.

Method of Mining in Indiana Coal Fields. Floyd W. Parsons. Illustrated description. Suggests a plan for preventing squeezes due to hard roof and soft bottom. 2000 w. Eng & Min Jour—March 23, 1907. No. 83224.

Outputs.

Large Coal Mine Uutputs. F. C. Keighley. A paper read before the Coal Mining Inst. of America. Discusses whether it pays to design and develop coal mines for very large outputs, and some of the causes that fix the limits. 3000 w. Mines & Min—March, 1907. No. 82760 C.

Peat.

The Technology and Uses of Peat. C. W. Parmelee. Abstracted from the annual report of the State Geologist of New Jersey. The present number considers peat as a fuel, giving information in regard to its heating power. 1500 w. Sci Am Sup—March 2, 1907. Serial. 1st part. No. 82810.

Pillars.

Removing Pillars in Coal Mines. William Hardy. Abstract of a paper read before the Coal Min. Inst. of America. Treats of the removal of pillars underlying surface waters, and the successful filling of worked out areas, cribbing, and the management of water. 2500 w. Min Wld—March 9, 1907. No. 82856.

Wyoming.

Coal in Wyoming. Information of this important mineral product, production, development, etc. 1500 w. Min Rept—March 21, 1907. No. 83230.

COPPER.

Air Compressor.

A Taylor System Air Compressor at the Victoria Copper Mine, Michigan. A. H. Rose. Illustrated description of a large air compressor built on lines developed from a water trompe of large size and giving economical results. 2500 w. Mines & Min—March, 1907. No. 82759 C.

California.

Trinity Copper Mine in California. Kirby Thomas. Map and detailed description of this property and account of its development. 3300 w. Min Wld—March 2, 1907. No. 82756.

Converter.

A Modern Electric Converter. G. B. Shipley. Describes the converter plant for the Orford Copper Co., at Constable, N. J. It consists of three electrically operated stands and nine shells. 2200 w. Min Wld—March 23, 1907. No. 83229.

Deep Mining.

Deep Mining in the Lake Superior Region. F. W. McNair. Abstract of address before the Am. Assn. for the Adv. of Sci. Illustrates and describes methods used at depths of about 5,000 ft. in the copper mines of this region. 3000 w. Min & Sci Pr—March 2, 1907. No. 82850.

Deposits.

Copper Deposits of Washington, U. S. A. Hon. Albert W. McIntyre. An interesting account of these deposits, explaining why their development has been slow, and giving much information in regard to the deposits in this state. 6000 w. B C Min Rec—Jan., 1907. No. 82848 B.

Nevada.

The Low-Grade Copper Deposits at Ely, Nevada. William Starr Bullock. Illustrated description of the extensive deposits and the proposed methods of working. 2200 w. Eng & Min Jour—March 16, 1907. No. 83073.

Ore-Bins.

Steel Ore-Bin Construction. W. R. Crane. Notes and sketches descriptive of the ore-bins at Shaft No. 3, of the Wolverine mine in the Lake Superior region. 2000 w. Min & Sci Pr—March 9, 1907. No. 83052.

Queensland.

The O. K. Copper Mine, North Queensland. R. Logan Jack. Report of a recent inspection of this field. 5500 w. Queens Gov Min Jour—Jan. 15, 1907. No. 82821 B.

Siberia.

Mining and Smelting in Southern Siberia. H. E. West. An illustrated account of properties examined, the nature of the deposits of copper, and related matters. 2000 w. Eng & Min Jour—March 9, 1907. No. 82817.

Wyoming.

Platinum-Copper Ores in Wyoming. Concerning the complex New Rambler ores and the concentration methods for an economical treatment. Ills. 1700 w. Min Rept—March 7, 1907. No. 82849.

GOLD AND SILVER.

Arizona.

The Vulture Mine, Arizona. C. W. Purington. An illustrated description of this mine and the deposits of gold in schist, with an account of the development. 2500 w. Min & Sci Pr—March 9, 1907. No. 83053.

Tombstone, Arizona, Restored. R. B. Brinsmade. An account of the rise and fall of this town, new developments at some of the old mines, yielding ore values in gold, silver and lead, application of the cyanide process, etc. Ills. 3800 w. Mines & Min—March, 1907. No. 82764 C.

Australia.

Metallurgy at Broken Hill, New South Wales. Ralph Stokes. An illustrated account of the treatment of these silver-lead ores, describing the new mill through which 6,000 tons of ore are passed per week. 3500 w. Min Wld—March 2, 1907. No. 82755.

Mining at Broken Hill, New South Wales. Ralph Stokes. An account of the methods of mining in this silver-lead district. 3500 w. Min Wld—March 9, 1907. No. 82854.

Concentration of Mixed Sulphides at Broken Hill (L'Enrichissement des Minerais Sulpurés Mixtes de Broken Hill). E. Lemiare. Description of the ores, the concentrating problem and the methods used to obtain a concentrate of the argentiferous galena. Ill. 5400 w. Génie Civil—Mar. 9, 1907. No. 82976 D.

Mining and Smelting at Mount Lyell. R. C. Sticht. From the annual report of the Zeehan School of Mines. Describes this mining district, the deposits, method of ore excavation, the values being in copper, gold and silver. 3500 w. Min Jour—March 2, 1907. Serial. 1st part. No. 82896 A.

British Columbia.

The Fraser as a Dredging Field. H. G. Stringer. An account of this river as a gold producer, and the attempts at dredging. Ills. 2200 w. Min Jour—March 16, 1907. No. 83269 A.

California.

The East Country of the Mother Lode.

John A. Reid. Describes the interesting features of the Shady Run mine. The ore deposits are a quartzose pyritic gold, and an ore rather low in silica, heavy with arseno-pyrite, and containing free gold. 1400 w. Min & Sci Pr—March 2, 1907. No. 82851.

Cobalt.

Cobalt, Canada, the New Silver-Mining District. J. E. Hardman. An illustrated review of the discovery, history, development and peculiar characteristics of this silver-bearing region. 2500 w. Engineering Magazine—April, 1907. No. 83311 B.

Method of Smelting Cobalt Ores. Hiram W. Hixon. Describes a proposed system for smelting these ores in Canada, stating the advantages. 900 w. Eng & Min Jour—March 2, 1907. No. 82689.

Mines and Mining at Cobalt. Willet G. Miller. Information in regard to the geology, characteristics of the veins, origin of the ores, production, etc. 3000 w. Can Min Jour—March 15, 1907. No. 82857.

Colorado.

The Gold Prince Mine and Mill. George P. Scholl and R. L. Herrick. An illustrated description of methods of mining on the Sunnyside Lode, the concentrating mill, tube mills, and methods of extraction for low-grade ores. 6500 w. Mines & Min—March, 1907. No. 82758 C.

The Maple Leaf Mine, Colorado. Arthur Lakes. Illustrates and describes the peculiar geological formation of this gold-bearing region. 1000 w. Min Wld—March 9, 1907. No. 82855.

Dredging.

Recent Applications of Gold Dredging Machinery. Francis C. Nicholas. Illustrates and describes a special dredge designed to save both placer gold and diamonds. Suggests its application in other fields. 900 w. Min Wld—March 23, 1907. No. 83228.

French Guiana.

Placer Mining in French Guiana. Leon Delvaux. An illustrated account of old and new methods on the Elysee placer, and the success. 2000 w. Eng & Min Jour—March 2, 1907. No. 82688.

Ketchikan.

The Ketchikan Mining District in Southeastern Alaska. An illustrated article giving particulars of the mines and smelters. 9000 w. B C Min Rec—Jan., 1907. No. 82847 B.

Klondike.

Placer Mining in the Klondike. Joseph B. Tyrrell. An illustrated account of the conditions prevailing in the district, and the interesting new methods developed. Extracted from a paper before the Inst. of Min. Engrs., London. 4000 w. Eng & Min Jour—March 2, 1907. No. 82686.

The Year 1906 in the Klondike District. J. P. Hutchins. A report of the year showing changes in plan of working, and discussing some of the problems of this region. 2500 w. Eng & Min Jour—March 16, 1907. No. 83076.

Nevada.

The Old Camps of Ward, Nevada. H. R. Plate. A brief historical review of the Martin White mine, a silver-lead producer of the '70s, and early '80s, which is to be worked for copper and lead. 1000 w. Min & Sci Pr—March 2, 1907. No. 82852.

Placers.

Conserving the Water Supply in Placer Mining. Dennis H. Stovall. Considers advantages gained by properly constructed reservoirs, to lengthen the hydraulic season, and the employment of a self-shooter. 1000 w. Ores & Metals—March 20, 1907. No. 83232.

Loss of Gold in Placer Mining. Dennis H. Stovall. Suggestions for a durable and efficient riffle, and remarks on causes of loss. 1000 w. Min & Sci Pr—Feb. 23, 1907. No. 82751.

Pockets.

Pockets in the Upper Portions of Gold Veins. George W. Kimble. Sketch and description of some of the pockets found in Eldorado County, California. 1200 w. Min & Sci Pr—March 16, 1907. No. 83195.

Precipitation.

Electrolytic Precipitation of Cyanide Solutions. Charles P. Richmond. Illustrates and describes the process used at the San Sebastian mine, San Salvador, which yields fine gold and separates the copper in a marketable form. 2500 w. Eng & Min Jour—March 16, 1907. No. 83074.

Rand.

Rand Mining Conditions. E. M. Weston. Begins a discussion of the cause of shortage of labor and other existing conditions. 2000 w. Aust Min Stand—Feb. 6, 1907. Serial. 1st part. No. 83129 B.

Slimes.

The Homestake Slime Plant. Mark Ehle, Jr. Illustrates and describes the Merrill automatically discharged filter press, and the plant for treating slimes carrying gold values of 80 cents per ton. 4000 w. Mines & Min—March, 1907. No. 82762 C.

Smelting.

Silver-Lead Smelting Practice. T. S. Austin. Discusses slag composition and characteristics, and furnace operations. 1800 w. Min & Sci Pr—Feb. 23, 1907. No. 82752.

South Africa.

Conditions Met in South African Mining. J. H. Pitchford. From an address before the students of the Univ. of California. Shows that in spite of the high cost of supplies, transportation, and labor, the low-grade gold-deposits are made to yield enormous profits. 5000 w. Eng & Min Jour—March 9, 1907. No. 82816.

Mining in South Africa. J. B. Pitchford. A lecture delivered to the mining students of the University of California, giving an account of the gold discoveries of this region and their development. 2000 w. Min & Sci Pr—March 9, 1907. Serial. 1st part. No. 83054.

IRON AND STEEL.

Blast Furnaces.

Some Modifications in Blast Furnace Construction. Julian Kennedy. Explains improvements made in furnace construction, which give greater safety to employees. Discussion. Ills. 4000 w. Pro Engrs' Soc of W Penn—Feb., 1907. No. 83034 D.

Efficiency.

Thermal Efficiency of Open-Hearth Furnaces. Considers the total heat available for the purposes of the furnace, and the distribution. 4500 w. Elec-Chem & Met Ind—March, 1907. No. 82872 C.

Gas Currents.

Direct Measurement of the Speed of Hot Gas Currents (Direkte Messung der Geschwindigkeit heisser Gasströme). R. Vambera and F. Schraml. Description of a simple method and calculation of results. Diagrams. 2200 w. Stahl und Eisen—Mar. 6, 1907. No. 82948 D.

Germany.

Treatment of Iron Ore (Die Bewertung der Eisenerze). M. Drees. Outline of present day German methods. 2300 w. Stahl und Eisen—Mar. 6, 1907. No. 82955 D.

Low-Grade Ores.

Utilizing Impure Iron Ores. Illustrated description of the Gröndel briquetting process for low-grade ores. 1400 w. Min Wld—March 16, 1907. No. 83089.

Metallography.

Crystallization of Iron (Sur la Cristallisation du Fer). F. Osmond and G. Cartaud. Comprehensive study of the crystal forms under different conditions. Illus. 12700 w. Bulletin de la Société d'Encouragement pour l'Industrie Nationale—Original Memoirs—Dec. 1, 1906. No. 82910 E + F.

Nomenclature.

Iron and Steel Nomenclature. Gives the metallurgical definitions presented by the committee at the Brussels Congress of the International Association for Testing Materials, which are to be submitted to the Iron and Steel Inst., and other organizations for indorsement. 2000 w. Ir Age—March 28, 1907. No. 83293.

Ontario.

Iron Mining in Northern Ontario. A. B. Willmott. Brief illustrated description of the more important exploratory work of the past year. 1300 w. Can Min Jour—March 15, 1907. No. 82859.

Pig Iron.

The Economical Production of Pig Iron.—A Study of Conditions Existing in the Blast Furnace. Horace Allen. A theoretical and mathematical discussion of the factors necessary for maximum efficiency. 2300 w. Ir Trd Rev—March 14, 1907. No. 83007.

Siemens-Martin.

Contribution to the Metallurgy of the Siemens Martin Process (Beitrag zur Metallurgie des Martinprozesses). Theodor Naske. Comprehensive account of researches on this subject. Diagrams. Serial. 4 parts. 12000 w. Stahl und Eisen—Jan. 30, Feb. 6, Feb. 13, and Feb. 20, 1907. No. 82951 each D.

Steel Works.

Imperial Japanese Government Steel Works at Wakamatsu. From a report by H. M. Charge d'Affaires at Tokio to the Board of Trade. Descriptive account. 2500 w. Ir & Coal Trds Rev—March 8, 1907. No. 83125 A.

Use of Electric Power in Ironworks (Die elektrische Kraftübertragung in Hüttenwerken). F. Janssen. Comprehensive account of European practice in use of electric driving. 7000 w. Stahl und Eisen—Feb. 20, 1907. No. 82953 D.

First Electrical Reversing Apparatus Installed at the Hildegard Works, Austria (Der erste elektrische Reversierstrassenantrieb, ausgeführt auf der Hildegardehütte). D. Geyer. Illus. Serial. 2 parts. 4600 w. Stahl und Eisen—Jan. 23 and 30, 1907. No. 82947 each D.

Ironworks Machinery (Maschinelle Einrichtungen für das Eisenhüttenwesen). Fr. Frölich. Various heavy machines described. Continuation of serial. Illus. 1900 w. Zeitschrift des Vereines Deutscher Ingeniure—Feb. 9, 1907. No. 82926 D.

Tempering.

Heyn's Experiments on the Tempering and Annealing of Steel (Les Experiences du Prof. Heyn la Trempe et le Revenu des Aciers). M. F. Osmond. Diagrams and tables. 3500 w. Bull de la Soc d'Encouragement pour l'Industrie Nationale—Original Memoirs—Dec. 1, 1906. No. 82913 E + F.

Tin Plates.

Rolling of Sheet Steel for Tin Plates. A descriptive account of the rolling of sheet metal. 2000 w. Prac Engr—March 15, 1907. No. 83260 A.

MINING.

Accidents.

Accidents due to Electricity in Mines

(Unfälle durch Elektrizität in Bergwerken). R. Rinkel. Enumeration and classification of casualties in European mines using electric power. 1200 w. Elektrotechnische Zeitschrift—Feb. 28, 1907. No. 82904 B.

Belt Elevators.

Belt Elevators for Ore and Water. Edward S. Wiard. Gives the writer's experience with these machines in wet concentrating mills, with advice as to methods of overcoming troubles. Ills. 4500 w. Eng & Min Jour—March 23, 1907. No. 83225.

Brazil.

The Mineral Industry of Brazil. Arrajado R. Lisboa. Information concerning the deposits and mining of gold, diamonds, manganese, iron, coal, copper, and monazitic sands. 2000 w. Eng & Min Jour—March 2, 1907. No. 82687.

Cave-in.

The Cave-in of an Inclined Shaft and Subsequent Rescue of an Entombed Miner, at Bakersfield, Cal. F. C. Finkle. Explains the nature of the work in hand and the plans for its construction, the accident and methods of rescue. Ills. 2000 w. Eng News—March 21, 1907. No. 83198.

Colorado.

A Trip to San Juan, Colorado. Prof. Arthur Lakes. Describes this region and some of the remarkable geological formations. 2000 w. Mines & Min—March, 1907. No. 82761 C.

Drilling.

A Miner's Drills and His Work with Them. Matt. W. Alderson. Points on the depth of holes drilled, their loading, etc. 900 w. Min & Sci Pr—March 2, 1907. No. 82853.

Drills.

History and Present Status of Air Hammer Drill. H. L. Sinclair. An account of the development of this tool for mining purposes, and a statement of its advantages. 3800 w. Ores & Metals—March 5, 1907. No. 82845.

Dynamite.

How the Miner's Dynamite is Made. Whitman Symmes. An explanation of the nitro-glycerine processes and the products used in its manufacture. 4000 w. Min & Sci Pr—March 9, 1907. Serial. 1st part. No. 83055.

Electric Winding.

Some New Flywheel Storage Systems. A. P. Wood. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Describes some three-phase and some continuous current systems, giving diagrams. 4000 w. Ir & Coal Trds Rev—Feb. 22, 1907. No. 82843 A.

Grab System.

Grab System of Mining at the Grant Mine, Buhl, Minn. Description of the grab system of stripping and mining as installed at this mine. 3000 w. Ir Trd Rev—March 14, 1907. No. 83008.

Labor.

Notes on Mexican Mine Labor. Carl A. Allen. An explanation of the systems of employing the Mexican, showing that he can be worked in most cases to better advantage as a day's pay man, and giving a comparison of the Mexican and American miner. 2200 w. Min & Sci Pr—March 16, 1907. No. 83196.

New Zealand.

History of Hydraulic Mining in New Zealand. John Ewing. Outlines the work of nature in the South Island of New Zealand, and the early methods of extraction of gold, describing the system of hydraulic elevating introduced in 1878. 2700 w. Min Jour—March 9, 1907. No. 83112 A.

Ore Reserves.

Notes on the Estimation and Valuation of Ore Reserves. W. R. Tait. A record of actual practice at the valuation of a mine on the Rand. 2300 w. Jour Chem, Met & Min Soc of S Africa—Jan., 1907. No. 83097 E.

Pumping Plant.

Discussion on Electrically-Driven Centrifugal Pumping Plant at the Tywarwhaile Mine. Discussion of W. R. Thomas' paper on this subject. 8000 w. Inst of Min & Met, Bul. 30—March 14, 1907. No. 83289 N.

Reduction.

Dry Air in Ore Reduction. Jos. H. Hart. Briefly explains the deterrent effects of moisture in the air in industrial applications, the existing methods of eliminating it, with their first costs and maintenance, and the increased economies that result. 1500 w. Min Wld—March 16, 1907. No. 83086.

Refrigeration.

The Adaptation of Refrigeration to Mining. Jos. H. Hart. Considers the application of mechanical refrigeration to cooling very deep mines, to stop water entering a mine, and to remove quicksand and mud, describing the compression and absorption systems. 2000 w. Min Wld—March 2, 1907. No. 82753.

Shaft-Sinking.

Shaft-Building by Raising. W. H. Storms. Illustrates and describes a practicable scheme for shaft-building by means of raising. 2000 w. Min & Sci Pr—Feb. 23, 1907. No. 82750.

Smelting.

The Location of Smelting Works. Herbert Lang. Advocates the one level plan, considering its advantages as compared with the terrace site. 3500 w. Eng & Min Jour—March 23, 1907. No. 83226.

The Smelter Smoke Problem. F. W. Traphagen. Read before the West. Assn. of Tech. Chem. & Met. Considers the possibility of damage to soil, to crops and to live stock, concluding that in some cases acid gases from smelter smoke may do damage, and recommending high stacks. 3000 w. Min Rept—March 14, 1907. No. 83085.

The Lead-Smelting Works of Port Pirie. Guillaume D. Delprat. Illustrates and describes smelting plant where the ores from Broken Hill are smelted and the bullion refined and prepared for market. 2500 w. Eng & Min Jour—March 16, 1907. No. 83075.

Ventilation.

Underground Fans as Main Ventilators. James Tonge. A reply to criticisms of an article on this subject. 2200 w. Mines & Min—March, 1907. No. 82763 C.

Winding.

Safety in Winding. George H. Winstanley. Read before the Nat. Assn. of Col. Mgrs. Classifies and discusses all the accidents possible. Also discussion. 9000 w. Ir & Coal Trds Rev—March 15, 1907. No. 83273 A.

MISCELLANY.

Bauxite.

The Bauxite Industry of the South. Edward K. Judd. Information in regard to the Georgia-Alabama district and its development. 2000 w. Eng & Min Jour—March 23, 1907. No. 83227.

Calcium.

Critical Discussion of the Electrolytic Method for the Production of Calcium (Kritische Betrachtungen über die Elektrolytische Gewinnung des Calciums). Carl Bürgel. Description of process. Illus. Serial. First and second instalments. 1300 w. Elektrotechnische Zeitschrift—Jan. and Feb., 1907. No. 82937 each G.

Chemistry.

Annual Review of Mineral Chemistry (Revue Annuelle de Chimie Minérale). A. Mailhe. A review of the progress of mineral chemistry in 1906, dealing with high temperatures, metalloids, metals and metallic salts. 5700 w. Rev Gen des Sci—Feb. 28, 1907. No. 82903 D.

Iceland.

Minerals of Iceland. L. P. Gratacap. Illustrates and describes some of the interesting minerals found. 2000 w. Min Wld—March 16, 1907. No. 83087.

Manganese.

The Crimora Manganese Mine. E. K. Judd. An account of the geology and methods of mining of this mine in Virginia. 1500 w. Eng & Min Jour—March 9, 1907. No. 82818.

Metallurgy.

Recent Developments in Metallurgy. S. F. Kirkpatrick. Gives examples showing the recent advances made. 2200 w. Can Min Jour—March 15, 1907. No. 82858.

New Zealand.

Prize Essay on the Mineral Resources of New Zealand. Robert McIntosh. A lengthy discussion of the present condition and future prospects of the mineral resources of New Zealand, and the best means of fostering their development. 56500 w. N Z Mines Rec—Jan. 16, 1907. No. 83208 B.

Phosphates.

Phosphate Mining in Tennessee. H. D. Ruhm. An illustrated review of development, and of the present situation and prospects. 3500 w. Eng & Min Jour—March 16, 1907. No. 83077.

Pyrometry.

See Electrical Engineering, Measurement.

Rare Minerals.

Rare Metals and Minerals and Their Uses. E. Schaaf-Regelman. Interesting information concerning the supply and demand of rare minerals, their use in high-speed tool-machines, tools, incandescent lighting, etc. 3500 w. Engineering Magazine—April, 1907. No. 83317 B.

Tin.

Revival of the Mining Industry in Cornwall. Edward Walker. An illustrated article explaining the geology and mineral deposits, and giving an account of modern methods which may restore abandoned properties to the list of producers. 4000 w. Eng & Min Jour—March 9, 1907. No. 82815.

Tin Smelting at Banka. J. Koomans. A short description of the smelting and refining. 1500 w. Min Jour—March 23, 1907. Serial. 1st part. No. 83421 A.

Zinc.

Design of a Zinc Smeltery. Reprint of Mr. Ingalls' views as given in the report of the British Columbia commission. Considers the technical and economical features of the plant. 3500 w. Ores & Metals—March 20, 1907. No. 83233.

The Zinc Industry in Colorado. The present article is a review of the history and production. 1000 w. Min Rept—Feb. 28, 1907. Serial. 1st part. No. 82748.

Zinc Mining in Mississippi Valley. E. Hedburg. Describes the deposits and gives information relating to the earnings from these mines. Ills. 1500 w. Min Wld—March 2, 1907. No. 82754.

Zinc in Eastern Tennessee. W. C. Clark. Describes the location of the deposits, nature of the ores, work done, etc. 1500 w. Mines & Min—April, 1907. No. 83397 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accounting.

Railway Records. U. H. Clarke. First of a series of articles on accounting and office records of the motive power department. 3500 w. Ry Mas Mech—March, 1907. Serial. 1st part. No. 82866.

Curves.

Danger to High Speed Trains on Curves. Richard T. Dana. Gives the results of a theoretical investigation of the general problem inspired by the recent accident on the New York Central R. R. 1500 w. Engng-Con—March 27, 1907. No. 83274.

Disasters.

Report on the Derailment of the "Pennsylvania 18-Hour Special" at Mineral Point, Pa.; Removal of Steel Cross-Ties. Gives the report of the investigating committee, with editorial, and an explanation of the ordered removal of the steel cross-ties. 2000 w. Eng News—March 7, 1907. No. 82798.

The New York Central Accident Investigation and the Action of Railway Trains on Curves. Editorial discussion of this accident with an outline of facts in connection with railway curve mechanics. 3800 w. Eng News—March 7, 1907. No. 82799.

Wreck of an Electric Train on the New York Central. An illustrated account of this accident and discussion of its cause. 1800 w. Sci Am—March 2, 1907. No. 82644.

Some Facts and Figures Bearing on the Bronx Park Derailment on the New York Central. Gives a summary of the three investigations of the accident that have been in progress and of the results. 5000 w. Eng News—March 14, 1907. No. 83139.

D., L. & W. Report.

Delaware, Lackawanna & Western. Reviews the report of this road for 1906. 2000 w. R R Gaz—March 1, 1907. No. 82679.

Italy.

Italian Government Railways. Thomas F. Millard. A brief review of conditions in Italy, explaining the circumstances which led to the taking over of the railway management by the government, and the results thus far. 1500 w. Ry Age—March 22, 1907. No. 83257.

Rules.

Working Regulations for Boston & Maine Enginemen. Gives the new code of rules adopted governing the conditions under which these men are to work. 2700 w. R R Gaz—March 1, 1907. No. 82680.

Transportation.

The Transportation Crisis. Lewis M. Haupt. First of a series of papers dealing with railroad development, relative freight rates in the United States and European countries, the danger of restrictive legislation, and the importance of regulating transportation facilities by the improvement of inland waterways. 2300 w. Mfrs' Rec—March 28, 1907. Serial. 1st part. No. 83299.

MOTIVE POWER AND EQUIPMENT.

Air Brake.

The New Continuous Air Brake (Le nouveau Frein Continu Pneumatique). C. Dantin. Detailed description of the mechanism and working of the Chapsal-Saillot brake. Ill. 2600 w. Génie Civil—Mar. 16, 1907. No. 82970 D.

Boilers.

Boilers for Railway Motor Cars. Illustrates and describes some of the more successful types of boilers used on the steam motor cars of England. 1200 w. Boiler Maker—March, 1907. No. 82678.

Brakes.

Mechanical Power Storage Brake. Illustrated description of this solution of the brake problem. 1800 w. Tram & Ry Wld—March 7, 1907. No. 83192 B.

Car Heating.

Heating Systems for Railway Cars. Prof. R. C. Carpenter. An illustrated paper discussing processes and methods of operation. 4000 w. Heat & Vent Mag—March, 1907. No. 83174.

Heating Trains by Steam (Nots sur l'Application du Chauffage des Trains par la Vapeur). M. Hallard. Describes the Heintz system in use on the lines of the Chemin de Fer du Midi, the apparatus used and the working of the system. Ill. 2400 w. Rev Gen des Chem de Fer—Feb., 1907. No. 82990 G.

Car Repairs.

Repairs to Steel Freight Cars. J. F. MacEnulty. Read before the New England R. R. Club. Illustrates some wrecked steel cars and discusses the cost of repairs and their care. 1600 w. Ir Trd Rev—March 7, 1907. No. 82786.

Cars.

Standard 40-Ton Box Car. Drawings and detailed description of a design for the New York Central lines; 6,000 cars having been ordered. 800 w. Am Engr & R R Jour—March, 1907. No. 82782 C.

Steel Passenger Cars. Illustrated description of the all-steel type passenger car for use in suburban service on the N. Y. C. & H. R. R. R. 2500 w. Am Engr & R R Jour—March, 1907. No. 82779 C.

Electrification.

On the Substitution of the Electric Motor for the Steam Locomotive. Lewis B. Stillwell and Henry St. Clair Putnam. The purpose of the paper is to record facts relative to heavy electric traction; to present calculations of costs; to show the importance of standardizing equipment; and to consider whether 25 or 15 cycles per second should be adopted in railway operation by alternating-current motors. 20800 w. Pro Am Inst of Elec Engrs—Jan., 1907. No. 83023 D.

On the Substitution of the Electric Motor for the Steam Locomotive. Editorial letter from Lewis B. Stillwell and H. S. Putnam in reply to a letter from G. B. Henderson, discussing features of the author's paper on this subject. 3500 w. St. Ry Jour—March 16, 1907. No. 83082.

The Substitution of the Electric Motor for the Steam Locomotive. Harrington Emerson. A criticism of conclusions reached by Mr. Lewis B. Stillwell and Mr. Henry St. Clair Putnam, in a recent paper before the Am. Inst. of Elec. Engrs., giving reasons for dissent. 2000 w. Ry Age—March 1, 1907. No. 82704.

Electrification of Steam Railroads. H. Ward Leonard. Quotes from letter by J. J. Hill which claims the great need of additional tracks, and claims that freight congestion can be relieved by increase of speed and loads. Advocates an International Electric Railway Commission to consider questions of trunk line electrification and solution of traffic congestion 1300 w. Elec Wld—March 16, 1907. No. 83128.

The Progress of Electricity on Steam Roads in 1906. Bion J. Arnold. Presidential address. Outlines work accomplished, in progress, and planned for the electrification of terminals and lines, and other great improvements such as the construction of tunnels, building of power stations, etc. 6000 w. Jour W Soc of Engrs—Feb., 1907. No. 83183 D.

Electric Traction for Steam Roads (Le Traction Electrique appliquée aux Chemins de Fer). M. N. Mazen. Comprehensive paper on the present state of heavy electric railway practice all over the world. Illus. 2 plates. 9800 w. Mem de la Société des Ingénieurs Civils de France—Dec., 1906. No. 82005 E + F.

Electric Traction for Steam Roads (La trazione elettrica sulle ferrovie). Pietro Lanino. Enumeration of most important electric installations on European and American railways. 3000 w. L'Elettricita—Jan. 25, 1907. No. 82903 D.

Locomotives.

Compound v. Simple Locomotives. A statement of facts and arguments bearing on this question, and aiding in determining whether, or not, compounding would be of service. 3300 w. Engr, Lond—March 1, 1907. No. 83004 A.

Counterbalancing the Balanced Compound Locomotive. O. W. Ott. Gives an example taken from actual practice. 1200 w. Ry Mas Mech—March, 1907. No. 82867.

Compound for the Mexican National. Illustration, with principal features of the design of a balanced compound Pacific type locomotive. 500 w. Ry & Loc Engng—March, 1907. No. 82698 C.

Consolidation Locomotive for the Nippon Tetsudo Kwaisha Railroad. Illustrated detailed description of an engine built in America for the narrow-gauge railroads of Japan. 800 w. R R Gaz—March 8, 1907. No. 82802.

The 4-Cylinder Locomotive in Great Britain. Charles S. Lake. Discusses the value of this locomotive in its compound and non-compound type, urging that it be given an impartial trial. 2000 w. Mech Engr—March 16, 1907. No. 83261 A.

Four-Cylinder Non-Compound Engine —Great Western Railway. Drawings, with brief note. 200 w. Engr, Lond—Feb. 22, 1907. No. 82841 A.

British-Built Locomotives for Service Abroad. Charles S. Lake. Introductory remarks on the British export trade, with illustrated description of some recently completed locomotives. 1200 w. Mech Engr—March 2, 1907. No. 82887 A.

A High-Speed Bavarian Locomotive. William Mayner. Illustration and short description of an engine exhibited at Nürnberg, designed for a normal speed of 94 miles an hour. 600 w. Sci Am—March 9, 1907. No. 82806.

German Tank Engines. Brief illustrated descriptions of a standard gauge and a narrow gauge engine for industrial railway service. 300 w. Ry & Loc Engng—March, 1907. No. 82699 C.

The Four-Cylinder Express Locomotives of the Danish State Railway. O. Busse. Chief dimensions and illustrated description. 1600 w. Bul Int Ry Cong—Feb., 1907. No. 83290 E.

Santa Fe Type Locomotive with Smokebox Superheater. Illustrated detailed description of a very heavy simple 2-10-2 locomotive for the P. S. & N. R. R. 800 w. Am Engr & R R Jour—March, 1907. No. 82780 C.

Tank Engine for the Nevada Northern. Illustrates and describes a suburban tank engine of the 2-8-2 type. 600 w. Ry & Loc Engng—March, 1907. No. 82701 C.

A Snow Locomotive for Logging Work. Illustrated description of an interesting engine for hauling logs on sleds over hard-packed snow. 600 w. Eng News—March 14, 1907. No. 83135.

Mallet System.

New Applications of the Mallet System to powerful American Locomotives (Nouvelles Applications du Système Mallet aux Locomotives Américaines de grande puissance). Henry Martin. Illustrated detailed description of Great Northern, Erie, and Baltimore and Ohio locomotives built on this system. Ill. 5500 w. Génie Civil—Feb. 9, 1907. No. 82986 D.

Motor Car.

Motor Cars with Gas Engine—Electric Motor Power Plant (Motorwagen mit elektrischer Kraftübertragung im Eisenbahnbetriebe). P. Poschenrieder. A car for use on steam roads in Austria. Enumeration of motor cars for steam roads and their performances in service. Illus. 4400 w. Elektrotechnische Zeitschrift—Feb. 28, 1907. No. 82965 B.

Rail Car.

A Flat Car for the Transport of Rails (Note sur un Wagon Platforme destine au Transporte des Dails de 15 à 24 mètres de longuer). M. M. Lambert. Gives a general description of this car and illustrates the more important structural details. Ill. 1700 w. Rev Gen des Chem de Fer—Feb., 1907. No. 82991 G.

Royal Train.

Metre-Gauge Royal Train for India. Illustrated description of the carriages of a train constructed for the special use of the Prince and Princess of Wales during their recent visit to India. 1000 w. Engng—March 8, 1907. Serial. 1st part. No. 83115 A.

Snow-Ploughs.

Snow-Plough for the Caledonian Railway. Illustrated description of an improved form of wedge-shaped plough. 300 w. Engng—March 8, 1907. No. 83116 A.

The Rotary in the Rockies. An illustrated article describing the large rotary snow plows used, and the work they accomplish. 1000 w. Ry & Loc Engng—March, 1907. No. 82697 C.

Train Control.

New Method of Controlling the Speed of Trains (Een nieuw toestel voor de contrôle van de snelheid van treinen). H. P. Maas Geesteranus. Illus. 3900 w. De Ingenieur—Feb. 2. 1907. No. 82956 D.

Train Lighting.

See Electrical Engineering, Light.

Valves.

The M Triple Valve. Illustrated description of this valve as applied in the electrification of the Rochester branch of the Erie Railroad. 1200 w. Ry & Loc Engng—March, 1907. No. 82702 C.

Wheels.

The Chilled Cast Iron Wheels. W. E. Fowler. Read before the Canadian Ry. Club. Discusses the wearing qualities, design, manufacture, and related matters of interest. 2500 w. Can Engr—March, 1907. No. 82696.

NEW PROJECTS.

Africa.

A New Trans-African Railroad from the Atlantic Seaboard to Lake Tanganyika. Illustrated detailed description of an important new line under construction, which will become an important factor in the development of a rich mineral district. 2800 w. Sci Am Sup—March 23, 1907. No. 83154.

Alaska.

Railway Routes in Alaska. Alfred H. Brooks. A discussion of railway projects, the location of lines, cost per mile, resources to be developed, minerals, agricultural possibilities, etc., showing there is justification for a trunk line railway from the Pacific seaboard to inland points. Maps and illustrations. 7000 w. Nat Geog Mag—March, 1907. No. 83295 C.

Australia.

Two New Australian Main Line Railways. Discusses the proposed transcontinental railway, 1,100 miles in length; and the main line to develop the northern coast of New South Wales, 311 miles long. 2400 w. Engr, Lond—Feb. 22, 1907. No. 82839 A.

Consolidation.

The Indianapolis Southern Railroad. Illustrated description of a consolidated line formed by a recently built line between Indianapolis and Switz City, Ind., and the Effingham district of the Illinois Central R. R. 2500 w. R R Gaz—March 15, 1907. No. 83058.

Cut-Offs.

The Bay Shore and Dumbarton Cut-Offs of the Southern Pacific. An illustrated description of these improvements which include the construction of tunnels, improvements of grades and curves, and secures a direct and easier entrance into San Francisco for the trains of the Coast division. 2200 w. R R Gaz—March 15, 1907. No. 83057.

The Genesee River Cut-Off of the Erie Railroad. Construction of a low-grade line between Hornell and Cuba is illustrated and described. 3000 w. Eng Rec—March 2, 1907. No. 82738.

Grand Trunk Pacific.

Location Surveys for the Eastern Half of the Grand Trunk Pacific. An account of the surveys of this new line taken from a recent address by H. D. Lumsden. 2500 w. R R Gaz—March 29, 1907. No. 83326.

Great Britain.

Current Railway Construction. An account of improvement and extensions in progress on British railways. 2700 w. Engng—March 8, 1907. No. 83118 A.

Improvements.

Norfolk & Western Improvement Work. George L. Fowler. Illustrated detailed description of reconstruction, double-tracking, improved grades and alinement. 5000 w. R R Gaz—March 15, 1907. Serial. 1st part. No. 83061.

Improvements and Extensions of the Union Pacific During 1906. R. L. Huntley. Map and information of work in Nebraska and Wyoming, including double-tracking, cut-offs, branch extensions, etc. 5400 w. Ry Age—March 22, 1907. No. 83253.

Bronx Improvement of the New York Central. Illustrated description of improvements involving a rearrangement of tracks and the building of a new station at Mott Haven. 1200 w. Ry Age—March 22, 1907. No. 83252.

Yonkers Improvement of the New York Central. Illustrates and describes very extensive changes, including the re-location of tracks, construction of extra tracks, elimination of grade crossings, new station, etc., explaining the conditions to be met. 1800 w. Ry Age—March 22, 1907. No. 83256.

The Pennsylvania Railroad Improvements Between Philadelphia and Baltimore. The principal feature is a new steel and masonry bridge, over the Susquehanna River. Also changes for the elimination of grade crossings, and the reducing of grades and curvature. 1000 w. Eng Rec—March 9, 1907. No. 82861.

Improvement Work on the Southwest System, Pennsylvania Lines. Describes an extension of the double-tracking, elimination of grade crossings, construction of coaling and water stations, etc. Ills. 1800 w. Ry & Engng Rev—March 16, 1907. No. 83091.

Improvements on the P. B. & W. R. R. at Havre de Grace, Md. Illustrates and describes details of this work, especially the new steel and masonry bridge over the Susquehanna River, at Havre de Grace. 1400 w. Ry & Engng Rev—March 23, 1907. No. 83249.

Tehuantepec.

The New Tehuantepec Railroad (Le nouveau Chemin de Fer de l'Isthene de Tehuantepec). A. Dumas. The history of the project, a description of the country through which the line passes, the harbour works at the terminals and other related matters. Ill. 3200 w. Génie Civil—Feb. 16, 1907. No. 82893 D.

Virginia.

The Tidewater and the Deepwater Railways. Maps and illustrated description of this line which will connect the West Virginia coalfields with tide water at Norfolk, Va. 9300 w. R R Gaz—March 15, 1907. No. 83060.

PERMANENT WAY AND BUILDINGS.

American.

American Railroads (Note sur les Voies Américaines). M. Descubes. Discusses rails, ties, methods of laying track, and other details of the roadbeds of American railways and compares with European practice. Ill. 3500 w. Rev Gen des Chem de Fer—Feb., 1907. No. 82992 G.

Chihuahua.

The Construction of the Chihuahua & Pacific Railroad. F. Lavis. An illustrated description of the work on the first section of this Mexican railway, which is extremely well built. 2800 w. Eng Rec —March 2, 1907. No. 82712.

Coaling Plant.

Coaling Plant with Dredge-Bucket at Cologne Station (Bekohlanlage mit Greifer auf dem Bahnhof Köln). C. Guillery. A coaling plant mounted on a traveler and provided with a drop bucket. Illus. 1500 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 23, 1907. No. 82919 D.

Curves.

Centrifugal Force on Curves and Its Resistance by Track. A study of the problem of track strength on curves made in connection with investigations of the recent accident on the New York Central Ills. 1200 w. Eng Rec—March 16, 1907. No. 83068.

Stresses in Tracks on Curves. A study of the mechanics of curve resistance, giving an outline of the calculations. 1700 w. R R Gaz—March 15, 1907. No. 83056.

The Relation of Locomotive Wheel Base to Track Curvature. George R. Henderson. A discussion of the effect of rigid wheel base and the corresponding clearances. 1200 w. Ry Age—March 8, 1907. No. 82873.

Otavi.

The Otavi Railway (Die Otavi-Bahn). M. Wechsler. Description of the location, construction, permanent way and rolling stock of a line recently opened in German Southwest Africa. Illus. 1 plate. Serial. 2 parts. 7800 w. Zeitschrift des Vereines Deutscher Ingenieure —Feb. 9 and 23, 7907. No. 82921 each D.

Shops.

Battle Creek Shops of the Grand Trunk Ry. General view, plan and detailed description. 2500 w. Ry & Engng Rev—March 9, 1907. No 82874.

Signalling.

Government Report on the Block System. Extracts from the last report of the Interstate Commerce Commission, dealing with automatic stops and other appliances not in general use, and those containing conclusions and recommendations of the commission. Also the mileage of railroad worked by the block system. 7000 w. R R Gaz—March 1, 1907. No. 82682.

Report on Block Signals. A review of the report of the interstate commerce commission on "Block Signal Systems and Appliances for the Automatic Control of Railway Trains." 3800 w. Ry Age—March 15, 1907. No. 83083.

Automatic Electric Block Signaling on the Boston & Maine Ry. Illustrated description of the double-blade electric semaphore block signals installed, with extracts from specifications. 2000 w. Eng News—March 7, 1907. No. 82797.

New and Old Signaling Problems. W. H. Elliott. Read before the N. England R. R. Club. Considers some of these problems, offering suggestions. 6000 w. R R Gaz—March 22, 1907. No. 83210.

New Signals on the Pennsylvania. Illustrates and describes the signalling equipment recently installed near Philadelphia, embodying the principle of upwardly inclined semaphore blades. Also editorial. 4000 w. Ry Age—March 15, 1907. No. 83084.

Upward-Inclination, Three-Position Signals, on the P. B. & W. Photographs, drawings and description of the installation of automatic block signals recently put in service. 2500 w. R R Gaz—March 15, 1907. No. 83063.

Steel Sleepers.

A Longitudinal Steel Sleeper System for Railroad Tracks. Gustav Lindenthal. Illustrated description of a steel foundation for railroad tracks, being tested on the Pennsylvania R. R. at Pomeroy Station. 1200 w. R R Gaz—March 15, 1907. No. 83059.

Switches.

Switch-Closing Devices and Switch Protection on Main Tracks. Editorial discussion of switch-closing devices, their dangers and advantges, and the protection of trains at turnouts. 2200 w. Eng News—March 28, 1907. No. 83323.

Switches and Turnouts Howard Chapin Ives. The present article presents a study of the frog, the switch, the lead rails on straight main track. 1600 w. Jour Worcester Poly Inst—March, 1907. Serial. 1st part. No. 83277 C.

Terminals.

The Theory of the Design of Railway Freight Terminals. H. M. North. Discusses the demands upon a freight terminal yard, the general types, the theory of design, the gravity yard, etc. 10400 w. Jour W Soc of Engrs—Feb., 1907. N.o 83187 D.

The Opening of the Lackawanna Terminal at Hoboken. Illustrations, and remarks on specifications of this fine terminal. 500 w. Ry Age—March 1, 1907. No. 82707.

The Present Condition of the Railway Terminal at Washington. Illustrated description, showing the progress made. 1800 w. Eng Rec—March 23, 1907. No. 83216.

The Flatbush Avenue Terminal of the Long Island Railroad. Chester A. Crandell. Illustrated detailed description of this common terminus of two distinct subways. 900 w. R R Gaz—March 29, 1907. No. 83327.

Ties.

Experiments with Concrete Ties. Report of the American Railway Engineering and Maintenance of Way Association which refers to concrete ties. 4000 w. Elec Ry Rev—March 23, 1907. No. 83237.

Steel Ties in the United States (Versuche mit flusseisernen Querschwellen in den Vereinigten Staaten von Nordamerika). K. A. Müllenhoff. Ties and fastenings described and compared. Illus. 1700 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 16, 1907. No. 82927 D.

Tracks.

A Study of the Stresses Existing in Track Superstructure. O. E. Selby, in Bul. 80 of the Am. Ry. Engng. & Main. of Way Assn. Discusses the unit stresses existing under present conditions, and the requirements for a more durable structure. 3000 w. Eng Rec—March 23, 1907. No. 83214.

Track Deformations and Their Prevention. G. Cuenot. Authorized translation of an account of experimental work undertaken to determine the strength of different kinds of cross-ties, their length, the extent of bed, etc. Also editorial. Ills. 6500 w. R R Gaz—March 15, 1907. No. 83062.

Warehouse.

The Terminal Warehouse of the Louisville & Nashville R. R. at Atlanta, Ga. Describes a 5-story reinforced concrete warehouse just completed. 2000 w. Eng Rec—March 2, 1907. No. 82740.

TRAFFIC.

Car Shortage.

Car Shortage. Arthur Hale. Discusses what is being done, and can be done, to reduce the car shortage. 2400 w. Ry Age—March 1, 1907. No. 82706.

Demurrage.

Reciprocal Demurrage. Editorial on the strong arguments presented by J. M.

Daly before the committee of the legislature of Iowa. 1500 w. R R Gaz—March 8, 1907. No. 82801.

Reciprocal Demurrage. E. D. Sewall. An argument against it. Also paper by J. M. Daly, and general discussion. 7000 w. Pro Iowa Ry Club—Feb. 8, 1907. No. 83157 C.

Reciprocal Demurrage. The statement before the committee of the Alabama legislature by Milton H. Smith, explaining the demurrage principle and the reasons why reciprocal demurrage is unfair. 3000 w. R R Gaz—March 8, 1907. No. 82803.

Immigrant Traffic.

Handling Immigrant Traffic at the Port of New York. An interesting illustrated article showing the care given immigrants by the government and the officials of the steamship lines and railroads. 3000 w. R R Gaz—March 8, 1907. No. 82804.

Rates.

Passenger Rate Regulation and the Canadian Parliament. S. J. McLean. A discussion of attempts being made to deal with passenger rates in Canada. 2000 w. R R Gaz—March 8, 1907. No. 82805.

An Increase in Freight Rates. Editorial presenting a summary of reasons why freight rates should be increased, and of objections to an increase, with facts presented by men in authority and conclusions. 2200 w. R R Gaz—March 29, 1907. No. 83324.

MISCELLANY.

Ash Handling.

The Ash Handling Plant of the Delaware, Lackawanna & Western R. R. at Scranton, Pa. Brief illustrated description of an efficient plant where frequently 300 engines are cleaned in a day. 800 w. Eng Rec—March 16, 1907. No. 83069.

Convention.

The Engineering and Maintenance of Way Association Convention. Abstracts of discussions, reports, and general business. 7000 w. R R Gaz—March 29, 1907. No. 83325.

India.

Notes on Indian Railway Systems. Abstracted from the Indian Government Railway Returns. Information relating to the railway systems, their equipment, operation, etc. 1600 w. Jour Soc of Arts—March 8, 1907. Serial. 1st part. No. 83096 A.

STREET AND ELECTRIC RAILWAYS

Car House.

The Broadway Car House of the International Railway Company. Thomas Pumfrey. Illustrates and describes the construction features of this new car house at Buffalo, N. Y. 3000 w. St Ry Jour—March 23, 1907. No. 83236.

Contact Wires.

A New Form of Suspension for Contact Wires. Discusses the strains in the contact wire and their effect, and illustrates and describes a new design for a suspender. 3300 w. R R Gaz—March 1, 1907. No. 82681.

Dispatching.

Dispatching Cars by Telephone, Denver City Tramway. S. W. Cantril. An explanation of the system and a description of the method of dispatching cars by telephone. Ills. 2000 w. Elec Ry Rev—March 2, 1907. No. 82747.

Earth Currents.

Some Theoretical Notes on the Reduction of Earth Currents from Electric Railway Systems by Means of Negative Feeders. George I. Rhodes. Considers the relative efficiencies of different return feeder systems in reducing stray currents. 1600 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83045 D.

Electric Locomotives.

Electric Locomotives for Heavy Service. An illustrated article calling attention to some interesting features of recent American-built machines. 1600 w. Elec Rev, N Y—March 23, 1907. No. 83223.

Electric Traction.

Electric Freight Locomotive Built by the Brooklyn Rapid Transit Company. Illustrated description of a large electric locomotive to be used for hauling as many as twenty freight cars from South Brooklyn to Coney Island, about 5 miles distant. 900 w. St Ry Jour—March 23, 1907. No. 83234.

New Electric Locomotives of the Boston Elevated Railway Company. Illustrated description of electric locomotives recently designed for heavy yard and general haulage service. 1000 w. St Ry Jour—March 2, 1907. No. 82685.

Development of Electric Traction (Le Dèveloppement de la Traction Electrique). M. De Valbreuze. Discussion of a paper on this subject read before the Société Internationale des Electriciens. Ill. 7500 w. Bul Soc Int d Elecns—Feb., 1907. No. 82981 F.

Interurban.

Electric Traction on Local Lines (La Traction Electrique sur les Lignes de Chemin de Fer d'Intérêt local). Eric Gérard. Discusses advantages and disadvantages of different types of current, transmission lines and other details of electric traction. 4000 w. Soc Belge d'Elec—Feb., 1907. No. 82988 F.

Operation and Construction of the Elgin & Belvidere Railway. R. H. Rice. Illustrated detailed description of this high-speed line in Illinois. 2000 w. Elec Ry Rev—March 9, 1907. No. 82870.

The Construction of the Bennington & North Adams Street Railway. Charles Rufus Harte. This line closes a gap in the trolley lines between Great Barrington, Mass., and Hoosick Falls, N. Y. Illustrated description of construction under many difficulties. 2000 w. Eng Rec—March 2, 1907. No. 82739.

The Manchester & Nashua Street Railway. Illustrated description of an important electric interurban line in southern New Hampshire. 2200 w. Elec Ry Rev—March 16, 1907. No. 83080.

The Evansville, Suburban & Newburgh Railway. Describes interesting features in the construction and operation of this line in Indiana, which gives steam freight service in addition to electric operation of passenger trains. Ills. 3500 w. St Ry Jour—March 16, 1907. No. 83081.

London.

The Rapid Transit Systems of London. Notes on recent improvement of transit facilities, especially considering motor omnibuses, electric street railways, and underground railways. Ills. 5000 w. Eng News—March 21, 1907. No. 83197.

Milan Exposition.

Electric Railways at the Milan Exposition (Die elektrischen Bahnen auf der Ausstellung in Mailand, 1906). A. Zweiling. Description of Europen practice as shown by cars, motors, etc., at Milan. Illus. 11400 w. Serial. 1st, 2d and 3d parts. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 2 and 16, and March 2, 1907. No. 82917 each D.

Municipal Ownership.

The New Orleans Public Belt Railroad. Map, description, and general information in regard to this belt railway which will encircle the greater part of the city. 1800 w. Ry Age—March 22, 1907. No. 83255.

Nashville, Tenn.

New Car House and Shops at Nashville. Illustrated description of well-designed buildings for shop and car-storage purposes. 1600 w. Elec Ry Rev—March 2, 1907. No. 82746.

Philadelphia.

Opening of the New Market Street Elevated Railway of the Philadelphia Rapid Transit System. Edward Hungerford. An account of the opening of the line, with illustrated description of the subway section, the elevated section, local stations, terminal stations, equipment and signals. 2800 w. Elec Ry Rev—March 9, 1907. No. 82869.

Power Stations.

Steam Power Station, Twin City Rapid Transit Company, Minneapolis, Minn. Illustrated detailed description of a plant which operates in parallel with a water-power station of 10,000 h.p. capacity located about 1,000 ft. away. Together they furnish power to ten electric railway sub-stations. 3000 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83042 D.

The Power Plant of the Spokane & Inland Empire R. R. Co. William F. Zimmermann. Brief illustrated description of this power development in the State of Washington. 1300 w. Eng Rec—March 2, 1907. No. 82718.

Shops.

Shops of the North Jersey Division of the Public Service Corporation. Illustrated detailed description of a large and finely equipped plant for shop work and car storage. 2000 w. Elec Ry Rev—March 16, 1907. Serial. 1st part. No. 83079.

Shop Practice at Memphis. An illustrated account of the work in these reorganized street railway shops during the last two years. 4000 w. St Ry Jour—March 2, 1907. No. 82684.

Signalling.

Power Signalling as Installed by the Underground Electric Railways Co., of London. Illustrated detailed description of the automatic signalling system. 2500 w. Elec Rev, Lond—March 15, 1907. Serial. 1st part. No. 83265 A.

Simplon.

The Electrification of the Simplon Tunnel Railroad. An illustrated description of this work and the methods of operating. 4000 w. Sci Am Sup—March 16, 1907. No. 83020.

Electrical Equipment of the Simplon Railway (Der Elektrische Betrieb der Simplon-Bahn). H. Rupp. Description of the line, overhead construction, locomotives, etc. Illus. Serial. 2 parts. 6900 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 9 and Mar. 9, 1907. No. 82925 each D.

Stations.

The Passenger Stations of the Hudson Companies. Brief illustrated description of the plans for the passenger stations in New York, Jersey City and Hoboken. 800 w. St Ry Jour—March 9, 1907. No. 82846.

Surface Contact.

The Dolter Surface-Contact System. Illustrated description of the application of this system to tramways at Torquay, Mexborough and Hastings, in England. 3500 w. Tram & Ry Wld—March 7, 1907. No. 83191 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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Serial publications are indexed on the appearance of the first installment.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *w.* Chicago.

Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.*- Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

Note—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to The Engineering Magazine.

Coal.

The Peabody Atlas, Shipping Mines and Coal Railroads in the Commercial District of the United States. By A. Bement. Size, 18 by 17 in.; pp. 149. Maps, 25. Ill. Price, $5.00. Chicago: Peabody Coal Co.

A valuable collection of geological, statistical, economic and commercial data of coal production and producers in the eastern United States. Especially important is its lists of working coal mines and their railway relations. An appendix with 47 figures is devoted to smokeless combustion and smoke-prevention devices.

Fire-Proof Construction.

The San Francisco Earthquake and Fire. By A. L. A. Himmelwright. Size, 9½ by 11 in.; pp. 270. Ill. Price, $5.00. New York: The Roebling Construction Co.

An engineer's report of the results of investigations made in San Francisco shortly after the earthquake and fire. Illustrates and describes eighty of the more important buildings, both fire-proof and non-fire-proof, in the burned district, giving more or less full details of the construction and the effects of the fire and the earthquake, with comments on the special features presented in each case. An effort is made "to point out those methods and details of construction which developed good efficiency in the fire and the earthquake; to call attention to those features of construction which were either defective or failed to fulfil the requirements; and to note important omissions in the designs." A final section gives a summary of the information obtained and outlines the valuable lessons which may be learned from the effects of the disaster. The volume contains a very large number of excellent illustrations.

Lathe Practice.

Modern American Lathe Practice. By Oscar E. Perrigo. Size, 9 by 6 in.; pp. 424. Ill., 315. Price, $2.50. New York: Norman W. Henley Publishing Company.

The history of the development of the lathe is traced from its crudest beginning to its present position as an intricate and highly efficient machine. The various types of lathes are carefully classified and their special features of design, construction and use are pointed out and briefly commented upon. A large part of the volume is devoted to a thorough discussion of lathe design and, in this, no essential element is overlooked. Tools, tool steels, and lathe testing and operation are discussed and in the final chapters the more important of the lathes at present on the market are described and compared. The book is a very complete treatise on this particular type of mechanical appliance and should prove valuable as a book of reference alike to the student, the designer, the mechanic, and the manufacturer and purchaser of lathes. It contains a large number of illustrations made especially for this work.

Municipal Ownership.

The Dangers of Municipal Ownership. By Robert P. Porter, Director of Eleventh U. S. Census. Size, 8¼ by 5¾ in.; pp. xi, 356. Price, $1.80. New York: The Century Co.

The book was prepared in Great Britain, being based largely upon addresses delivered by the author before the British Association, the British Society of Arts, the London School of Economics and the London Chamber of Commerce. It is essentially a summary of British experience during the thirty years or more of "municipal trading" which are now available for study, with collateral examination of the results of the same policy on the Continent and in the Colonies, especially Australasia. A very strong case against the policy is established, on the grounds that it furnishes very inefficient and unprogressive service, rolls up a huge public debt, and strangles industrial enterprise.

Panama Canal.

Problems of the Panama Canal. By Brig.-Gen. Henry L. Abbot. New edition, revised. Size, 9 by 6 in.; pp. xii, 261. Figures, xv. Map. Tables. Ill. Price, $2.00 net. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

Revised and enlarged from the original edition of 1905, with a new chapter on

"The Canals under the Control of the United States," a new section of chapter 7 discussing the projects of the Board of Consulting Engineers, additional climatological and hydraulic data covering the two and one-half years elapsed since the first edition appeared, and eight half-tone plates. It brings the history of the undertaking down to the opening of 1907, supplying an admirable review of the engineering studies and effort from the inception of the enterprise, and the technical data of "every essential element having a bearing upon the construction of the best possible canal."

Steam Engineering.

Modern Steam Engineering. By Gardner D. Hiscox. Size, 9 by 6 in.; pp. 487. Ill. Price, $3.00. New York: Norman W. Henley Publishing Company.

The aim of the author has been to produce a book which would "fully meet the wants of the student and engineer in all the practical requirements for obtaining a mastery in the application and use of steam for power and other purposes in the full range of its usefulness." With a view to the requirements of the practical man, the mathematical side of steam engineering has been simplified as much as possible and chapters are added on the duties of an engineer, and on the practical care and management of elevators and of refrigeration and electric-light plants. A large number of typical questions asked by licensing boards are given with full answers. Chapters on superheated steam and the steam turbine bring the work fully up to date and round out an extremely practical and well written treatise. The large number of excellent illustrations add greatly to the value of the work as a book of reference for students.

Steam Turbines.

Steam Turbines. By Lester G. French. Size, 9 by 6 in.; pp. vi, 418. Ill. Price, $3.00. Brattleboro, Vt.: The Technical Press.

A large part of the material contained in this volume was collected by the author during the nine years of his editorship of *Machinery* and several articles which appeared in that publication are here reproduced in more or less modified form. The greater part of the matter, however, has been written especially for this work. The author aims to treat the subject from the point of view of the practical man and to this end mathematical discussions have been introduced only where absolutely necessary and graphical solutions have been used wherever possible. Comprehensive historical and descriptive information is given and much attention has been devoted to results of tests upon the flow of steam, upon the action of steam on vanes, and upon the economic properties of turbines. Chapters on the Commercial Aspect of the Turbine and the Status of the Marine Turbine bring the work fully up to date.

Steel.

The Manufacture and Properties of Iron and Steel. By Harry Huse Campbell. Fourth Edition. Size, 9 by 6 in.; pp. xxvi, 639. Figures, lxxi. Tables, ccxlv. Price, $5.00. New York and London: Hill Publishing Company.

The latest edition of this standard work on the metallurgy of iron and steel, like its predecessors, aims to present the permanent fundamental principles of the subject rather than descriptions of apparatus and processes which are subject to constant alteration. In the main, it resembles former editions in subject matter and arrangement. In order to keep the size of the book within the limits of convenience, all unnecessary phrases or words have been eliminated, and some of the matter contained in previous editions has been omitted from the present volume. On the other hand, new knowledge has been interpolated in a hundred places, notably in the chapter on the Influence of Certain Elements on the Physical Properties of Steel.

Technical Dictionary.

Illustrated Technical Dictionary, in Six Languages. Compiled by K. Deinhardt and A. Schlomann; edited by P. Stülpnagel. Size, 7 by 4 in.; pp. 403. Ill. Price, $2.00. New York: McGraw Publishing Co. London: Archibald, Constable & Co.

The first of a series of illustrated technical dictionaries, each to be devoted to a specialized branch of engineering. The volume in hand takes up machine elements and tools, and following books will cover electric plants, steam boilers and engines, hydraulic appliances, hoisting and conveying machinery, machine tools, structural ironwork, metallurgy, architecture, and marine engineering. The method of definition is the simple, visual one of making a picture of the object—the only plan feasible in this peculiar field. Beside the cut are placed the equivalent terms in English, French, German, Russian, Italian, and Spanish. Objects are grouped by their natural mechanical or structural associations. At the back of the book an alphabetically arranged word list refers the consultant to the page and position where any given term will be found. A test of its completeness made by taking a good number of terms at random indicates painstaking thoroughness on the part of the compilers and the editor. Those who have attempted technical translation know best how sorely an accurate work of this kind has been needed and how warmly it should be welcomed.

Tests.

Bulletins of the Engineering Experiment Station, University of Illinois. Volume I. Size, 9 by 6 in.; pp. about 450, with many illustrations, figures, and tables. Urbana: The University of Illinois.

An assembly into one volume of the most important work of the Experiment Station from Sept., 1904, to Sept., 1906, covering Bulletins 1 to 8 and circulars 1 and 2. The subjects included are: Tests of Reinforced Concrete Beams; High-Speed Tool Steels; Tests of High-Speed Tool Steels on Cast Iron; Drainage of Earth Roads; The Engineering Experiment Station of the University of Illinois; Tests of Reinforced Concrete Beams, Series of 1905; Resistance of Tubes to Collapse; Holding Power of Railroad Spikes; Fuel Tests with Illinois Coals; Tests of Concrete: I. Shear. II. Bond.

BOOKS RECEIVED.

Motori a Gas. By Vittorio Calzavara. Size, 6 by 4 in.; pp. xxxi, 415. Ill. Price, L 4.50. Milan: Ulrico Hoepli.

Carboni Fossili Inglesi. By Guglielmo Gherardi. Size, 6 by 4 in.; pp. xvi, 586. Ill. Price, L 6. Milan: Ulrico Hoepli.

Stampaggio a Caldo e Bolloneria. By Gino Scanferlá. Size, 6 by 4 in.; pp. viii, 165. Ill. Price, L 2. Milan: Ulrico Hoepli.

Alternating Currents. By Alfred Hay. Size, 8½ by 5½ in.; pp. xiv, 291. Ill. Price, $2.50. New York: D. Van Nostrand Company.

Catechism on Producer-Gas. By Samuel S. Wyer. Size, 7 by 4½ in.; pp. 42. Ill. Price, $1. New York: McGraw Publishing Company.

Elements of Mining, Geology and Metallurgy. By G. W. Miller. Size, 8 by 5 in.; pp. xiv, 480. Ill. Price, $3.50. Denver, Col.: The Daily Mining Record.

A Practical Manual of Tides and Waves. By W. H. Wheeler. Size, 9 by 6 in.; pp. vi, 201. Ill. Price, $2.80, 16/. New York and London: Longmans, Green & Co.

Producer-Gas and Gas Producers. By Samuel S. Wyer. Size, 9 by 6 in.; pp. 296. Ill. Price, $4, 17/. New York and London: Engineering and Mining Journal.

Life as an Engineer. By J. W. C. Haldane. Size, 7½ by 5 in.; pp. xix, 338. Ill. Price, $2, 5/. New York: Spon and Chamberlain. London: E. & F. N. Spon, Ltd.

Mechanics Problems. By Frank B. Sanborn. Size, 8 by 5½ in.; pp. viii, 194. Ill. Price, $1.50, 6/6. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Tools for Machinists and Woodworkers. By Joseph G. Horner. Size, 8¼ by 5½ in.; pp. xiii, 291. Ill. Price, $3.50. New York: Norman W. Henley Publishing Company.

Differential Equations. By Donald Francis Campbell. Size, 7½ by 5 in.; pp. vii, 96. Price, 90 cents. New York: The MacMillan Company. London: MacMillan & Co., Ltd.

Handbook of Mathematics. By J. Claudel. Translated by Otis Allen Kenyon. Size, 9½ by 6½ in.; pp. ix, 708. Ill. Price, $3.50. New York: McGraw Publishing Company.

Economics of Road Construction. By Halbert Powers Gillette. Second Edition. Size, 9 by 6 in.; pp. 49. Ill. Price, $1. New York: Engineering News Publishing Company.

Steam Turbines. By W. Gentsch. Translated by A. R. Liddell. Size, 10½ by 7 in.; pp. viii, 375. Ill. Price, $6, 21/. New York and London: Longmans, Green and Company.

Elements of Mechanical Drawing. By Alfred A. Titsworth. Size, 7 by 10 in.; pp. vi, 130. Ill. Price, $1.25, 5/6. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Ventilation, Heating and Lighting of Dwellings. By J. W. Thomas. Size, 7½ by 5 in.; pp. xi, 284. Ill. Price, $2, 6/. New York and London: Longmans, Green & Co.

Continuous-Current Dynamo Design. By H. M. Hobart. Size, 9½ by 6 in.; pp. x, 220. Ill. Price, $3, 12/6. New York: The MacMillan Company. London: Whittaker and Company.

Electrical Engineering in Theory and Practice. By G. D. Aspinall Parr. Size, 9 by 6 in.; pp. viii, 447. Ill. Price, $3.25, 12/. New York: The MacMillan Company. London: MacMillan & Co., Ltd.

Industrial Furnaces and Methods of Control. By Emilio Damour. Translated by A. L. Queneau. Size, 9 by 6 in.; pp. xiv, 317. Ill. Price, $4, 17/. New York and London: Engineering and Mining Journal.

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXXIII. JUNE, 1907. No. 3.

"MADE IN GERMANY." A STUDY OF COMPETITION.

By Louis Bell, Ph.D.

Dr. Bell's article will be appreciated most by those who read in this Magazine last September his striking discussion of American manufacturing methods and their tendencies. To all, however, this more concrete presentation of the topic will carry much of interest and will offer suggestions worthy of careful examination. It is an important contribution to a problem which is likely soon to become acute throughout the world—the problem of competition, in home and foreign markets, between great manufacturing nations under differing economic policies and industrial systems. Dr. Bell, though an American of the Americans, treats it from an impartial viewpoint and with admirable breadth of vision.—THE EDITORS.

IN a previous paper the writer drew attention to some inherent faults in the "American method" of manufacture. The effects of these faults, and of the causes which have produced them, upon the distribution of world trade have become worthy of serious consideration by economists. At the present time the United States stands with a tremendous balance of trade to its credit. There is happily continued prosperity, and industry is active. If, however, one studies carefully the official returns of imports and exports the fact is evident that in the last analysis Americans are chiefly purveyors of raw material and food-stuffs, together with some important natural products in more or less complete conditions of manufacture. Of strictly manufactured articles there is of course a vast and varied assortment, but it is rather more remarkable for what it omits than for what it contains, particularly if one eliminates the Canadian trade. In a sense we are a great manufacturing country, for the native market is immense, yet it is rather curious that we should import many things which we do, considering the activity of the American manufacturer. "Made in Germany," or France, or England, is a label the frequency of which deserves some investigation.

Why, for example, should we have imported last year, against heavy duties, some $69,000,000 of manufactures of cotton? Certainly the American cotton manufacturer is not lacking in skill or foresight, yet despite the fact that we export the bulk of the world's raw cotton the balance of trade is always very heavily against us in the finished product. The imports of china, earthenware, glass, and glassware nominally run up to $20,000,000 or thereabouts, against exports almost negligible; and yet it is quite certain that native American skill can and occasionally does produce porcelain and glass of the very finest quality. The Trenton potteries, for example, are potentially capable of meeting the Europeans on their own ground. We import likewise some $15,000,000 worth of woolen cloths and nearly $10,000,000 worth of gloves, all again against heavy duties. And so the list might be extended over a wide range of manufacture, including even six or seven million dollars worth of toys.

Even in watches, loudly heralded as the finest fruit of the American method, in spite of cut rates for export, the balance of trade is steadily against us. Were the United States a free-trade country we might charge up these things to foreign cheap labor, but the protective tariff is in many cases stiff enough to cover the whole actual cost of labor at American rates with a liberal margin beside. Why then does the foreign-made label continually confront one?

Even in things like machinery, to which the American methods have been assiduously applied and which we export in large amounts, it seems to be difficult or impossible to meet the market fully enough to check heavy imports against large duties. What manner of necessity was it that caused the importation last year of about $4,500,000 worth of miscellaneous machinery?

In foreign trade, in spite of many successful inroads by American manufacturers, it has proved to be difficult to hold our own even by cutting prices for export. The South American trade is steadily slipping away and that in the Far East is menaced. Of course the carrying trade has long since passed out of American hands and the flag is now seldom seen in a foreign port. This adverse fact is not sufficient, however, to account for the difficulty of successful competition in these markets. It is not a mere question of the flag over the taffrail, but of goods and of prices, of credits and of methods of sale.

It is of course a matter of comparative indifference in these busy times, with every factory behind its orders and deliveries growing

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BOUND VOLUMES, containing the numbers for six months, in half Morocco, $3.00; half Russia, $2.75; half American seal, $2.75; full sheep, $2.75; cloth, $2.50. These prices are subject to change, when volumes are out of stock, necessitating the special binding of magazines, for which a premium has been paid. Back numbers will be exchanged, if in good condition, for corresponding bound volumes in half Morocco for $1.50; half Russia. $1.25; half American seal, $1.25; full sheep, $1.25; cloth, $1.00 per volume (six numbers). Charges should be prepaid on copies forwarded for exchange, and 40 cents added to the price per volume to prepay postage or express charges on bound volumes.

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AUTHORS AND PAPERS FOR JUNE, 1907

LOUIS BELL, Ph. D. *("Made in Germany," a Study of Competition)*—Graduated from Dartmouth College, 1884, and took the degree of Ph. D. at Johns Hopkins University, 1888; professor of Physics and Applied Electricity at Purdue University, Lafayette, Ind., 1888-89; consulting engineer, Chicago (firm of Bliss & Bell), 1889; editor of *The Electrical World*, N. Y., 1890-91; member A. I. E. E., 1890; engineer in charge of power-transmission work of the General Electric Co., 1892-95; at present consulting engineer, Boston, Mass., making a specialty of power transmission and heavy electric-railway work.

HENRY W. JACOBS *(The Square Deal for the Railway Employee)*—Born 1874; 1888-1894, apprentice, machinist, moulder, structural iron worker, with the Seaton Foundry, Atchison, Kansas; machinist with the U. S. Gun Shop, Washington, D. C.; marine experience with U. S. Government, testing engines, trial runs, etc.; machine and erecting machinist, with the Sprague Electric Company, R. Hoe and Company, and Crocker & Wheeler; 1899, manager, Vulcan Engineering Company, engaged in repairs and building of stationary and marine machinery; 1900, took up railway work as erecting machinist, K. C. S. J. & C. B. Ry. Tool-room foreman, Burlington Railroad; general shop demonstrator, Union Pacific Railroad, engineer of methods for one of the largest railway systems in the western United States; now assistant superintendent of motive power, A. T. & S. F. Railway; member, American Society of Mechanical Engineers.

H. VON SCHON *(Hydro-Electric versus Steam Power for Industrial Plants)*—Born in Germany, graduating from Berlin in 1869; for thirty years a specialist in hydraulic engineering; several years were spent by him in connection with the U. S. Engineer Corps in surveys of the Great Lakes, but for the last twelve years he has devoted himself exclusively to the designing of hydro-electric power installations. The most important of the many he has planned is that at the foot of Lake Superior, notable as utilizing the largest flow—some 30,000 second feet—while that at Eugenia Falls, Ontario, uses only 80 second feet, but a head of 400 feet. Mr. von Schon has originated a number of valuable features, one of which, the submerged power house, has been incorporated recently in a plant at Patapsco, Md., the entire generating equipment being placed in the interior of the dam, with the spillway water rolling over the power-house roof. He is a member of the American Society of Civil Engineers.

CHARLES U. CARPENTER *(Profit Making in Shop and Factory Management)*—A graduate of Princeton University with the degrees of mechanical and electrical engineer, has had a large experience in mining engineering and electrical manufacturing and in the supervision of large manufacturing plants; for some years he was factory supervisor and afterwards head of the labor department of the National Cash Register Company, Dayton, Ohio, U. S. A. Later took a similar position with the Herring-Hall-Marvin Safe Company, rising rapidly to the presidency of the concern.

LEONARD C. WASON *(Reinforced-Concrete Buildings for Manufacturing Purposes)*—Graduated from the Massachusetts Institute of Technology in 1891; since 1894 has devoted his entire time to reinforced-concrete construction as a contracting engineer; in the early days, a large number of original experiments were conducted under his initiative at the laboratories of the Institute and at the Watertown Arsenal in order to determine what could and what could not be done safely. For the design of more than nine-tenths of all the structures which have been built by his firm he was responsible, in whole or part. He has therefore acquired an experience in designing combined with close and almost daily observation of work in progress which gives an unusual insight into costs of different types of construction and the cheapest type in any given case.

GEORGE F. STRATTON *(The Pursuit of Inventing a Business)*—For thirty years connected with manufacturing corporations in various capacities, in the factory, the office, and on the road. For ten years past has been with the General Electric Co. at their Lynn works, where 10,000 hands are employed.

His intimate acquaintance with engineers and officials has thus afforded him ample opportunities for observing the working of one of the greatest of American machine shops.

WILLIAM D. ENNIS *(Efficiency in the Burning of Fuel Under the Steam Boiler)*—Apprenticed to the Rogers Locomotive Company; drafting office, Passaic Rolling Mill Company; engine-room, Consolidated Gas Company of New Jersey; engineer of construction, Walworth Construction and Supply Company; designing engineer, Tower and Wallace. From 1901, employed in various engineering capacities in industries personally controlled by Mr. John D. Rockefeller, including the Puget Sound Reduction Company, the Monte Cristo Railway Company, the Everett (Wash.) Pulp and Paper Company, and finally, the American Linseed Company, where he served successively as constructing engineer, chief engineer, and engineer-superintendent. A specialist in power-plant operation; has devoted attention to a constantly increasing extent to the general subject of economical production. A frequent contributor to the technical literature of both subjects.

RODOLPHE MATHOT *(The Design of Modern Producers and Gas Engines)*—A consulting engineer, at present resident in Brussels, Belgium; specialist in gas-producing machinery and gas and other internal-combustion engines; member of the Institution of Mechanical Engineers, of the Société des Ingénieurs Civils de France, etc.; author of the recently published work "Gas Engines and Producer-Gas Plant" (Norman W. Henley, 1905) which received a most flattering introduction from Mr. Dugald Clerk.

FREDERICK KEFFER *(Methods of Mining in the Boundary District, British Columbia)*—A graduate in mining engineering of the Ohio State University and was connected with the staff of the mining department for some time after graduation. Following this, was connected with various mining companies in the United States and Mexico. In 1896, was appointed chief engineer and general manager of the British Columbia Copper Company, Greenwood, B. C., at the time of the formation of the company with which he has been connected ever since. In 1906, gave up the active managership of the company, which has developed into one of the largest producers of British Columbia, and now acts as consulting engineer with general oversight over the numerous working properties of the company. Is a member of the American Institute of Mining Engineers and was recently elected President of the Canadian Mining Institute.

P. F. WALKER *(The Properties and Use of Mineral Lubricating Oils)*—Graduate in mechanical engineering, University of Maine, 1896; instructor in mechanical engineering, University of Maine, 1896-1900; draftsman, Bath Iron Works, Bath, Me., summers of 1899 and 1900; graduate student of Cornell University, Marine Engineering Department, 1900-1901, taking degree of Master of Mechanical Engineering; draftsman in Estimating and Scientific Department of Newport News Shipbuilding Co., Newport News, Va., 1901-1902; professor of mechanical engineering, University of Maine; 1902-1905; professor of mechanical engineering, University of Kansas, 1905 to date. Engaged on oil tests for Kansas University State Geological Survey, 1906 to date.

TON-MILES IN A TROY COST LEAST FOR REPAIRS

In measuring the economic efficiency of a freight car, it is the practice to record the number of miles that it travels and the number of tons that it hauls. The two multiplied together give the ton-miles. The total cost of repairs to the freight car is divided by the total ton-mileage, and the quotient gives the cost per ton-mile for repairs. In like manner certain contractors keep approximate records of the cost per ton-mile of hauling done in wagons, both as to wages and as to maintenance and depreciation. If all contractors were to do this, and if every contractor were to begin by owning even one Troy wagon, there would be no other dump wagon in use in less than five years' time. Troys are built to carry as heavy loads as can be piled upon them. The simplicity of the dump mechanism, the use of indestructible steel doors, the use of steel "ironing" throughout instead of castings, and the strongest running gear ever made, make the Troy wagon superior in durability to all competitors. Having been in the wagon making business longer than any competitor who makes a specialty of dump wagons, it is not to be wondered that we have learned now to make wagons that last, nor that we have been keenly alive to the importance of durability as a factor in getting repeat orders for our product. It happens, also, that we make the only sand-tight bottom dump wagon. Its steel doors lap on each other. Send for catalog No. 2 E. M.

THE TROY WAGON WORKS COMPANY
CRAWFORD AND WEST STREETS, TROY, OHIO

longer, whether an order in Brazil comes to the United States or goes to Germany. What, however, will be the result when home markets have grown a little more sluggish and works are operating below their normal capacity? Will not there come a time when a world market will be sadly needed and will be found well occupied by those who are now mastering it? It is such a contingency that makes one pause and consider carefully the relation of the methods and temper of American business to foreign competition at home and abroad. There may be no immediate danger of a Zollverein against American industry, yet it is absolutely certain that there will be steady and effective pressure brought to bear against the American tariff which directly or indirectly will force it downward on pain of retaliation.

When this time shall come, and it is already in sight, the "Made in Germany," or elsewhere, mark will be seen on a somewhat wider range of goods—unless the market can be held by means evidently not now applied.

As regards importations to the United States the fundamental questions are: What goods can be profitably imported against the present duties, and why are they not met by effective competition here? The answers will bring us back in part to the failings of the American method and in part to the general conditions that have grown up in intimate association with that method.

It is not an easy matter to analyze the list of imports with precision, since its classification is not adapted to minute investigation. Aside from natural products not produced in America, and some classes of manufactures which for particular rather than general reasons are especially at an advantage abroad, the manufactured imports fall rather naturally into three categories. First may be considered those goods which are practically not produced at all in the United States. Second come those which are here produced only in limited quantities and at a very high price or of dubious quality. Third, those which can be produced, and are produced, but are unable to drive out steady foreign competition by reason of quite various causes. The relations of these categories to the theory and practice of American manufacturing are somewhat intricate, but out of them can be gathered some data on the main questions at issue, and perhaps some intimation of remedies. If one were to venture upon any generalization regarding imports it would probably be to the effect that the goods brought into the country are of the very highest and the very lowest grades, the product on the one hand of the finest skilled labor and on the other of extremely cheap labor applied to a sometimes rather crude imitation of American methods.

The first category, of goods rarely or never made in America, would be a fairly long one composed of very widely diversified items, mainly those in which manufacture depends upon great manual or technical skill. Synthetic dyestuffs, many fabrics, chronometers, and optical glass, are excellent samples of the list. With respect to the first mentioned, the United States is not absolutely without product, but there is almost complete dependence upon Germany for colors, imported to the extent of five or six million dollars annually. Organic chemistry is a branch of science peculiarly neglected in this country, where technical training has generally run to other lines for which there is greater demand. The same impulsive desire to "get there day before yesterday" which is one of the sources of our national greatness, sadly handicaps technical education. Even our institutions of learning when attacked by an itching for "productive scholarship" sometimes do queer things. The president of one well-known University used to send to his heads of departments a monthly blank to be filled out with researches published or begun and notices of public lectures given by the incumbent. One is irresistibly reminded of the fine irascible old colonel in winter camp during the Civil War, who being informed by his chaplain that a very productive "revival" was in progress in the neighboring regiment promptly called up the officer of the day and directed him to detail thirty men to be baptized immediately, allowing that he would be blankety-blanked if he would be outdone by that Nth Ohio!

In chronometers the American method seems to strike its limitation. Occasional instruments bear an American name, but even these are often imported in parts and merely assembled and engraved here. The fine care and precision required cannot be replaced by assembling machine-made parts at random and inspecting the product only by sample, even if the machine work is fully up to the high plane reached in American watch factories.

In textile manufactures it is notorious that certain classes of goods can be secured only abroad. These are perhaps most generally such as require a relatively large labor cost, either in hand work or in care of machines. The American ideal of one low-paid girl attending a group of eight or ten automatic looms does not tend to the production of the finest fabrics, and in spite of everything cheap labor will not stay cheap on American soil. The early New England mills were run by native-born operators; then came the great tide of Irish immigrants; then another tide of French from across the Canadian border; and now it is Armenian, Greek, Polak, Italian—anybody who will temporarily break the price of labor. When these shall have settled themselves, as they will with astonishing rapidity, to American standards of living, it will be increasingly difficult to compete with foreign goods of the higher grades. Aside from the eternal labor question there seems to be an artistic skill and refinement, a resourcefulness and an originality among the foreign textile experts and designers that it is hard to approximate here. In making "standard" goods of certain grades the American manufacturer is exceedingly skilful and successful, but importations of the present magnitude show his limitations.

To pass easily along this line into the second category one must take account again of certain grades of textiles which are successfully produced here, but in very limited amounts and at prices which can compete with imports only on a modest scale. There are certain cotton mills which turn out particular classes of semi-standard fine goods of as beautiful quality as can be obtained anywhere in the world. But they are relatively few and small, and as a rule only moderately profitable. If one hears of a mill that is paying huge dividends, that mill is more than likely to make print-cloths or similar stuffs in which profit often depends chiefly on shrewd cotton buying.

Into this second category, too, fall such diverse articles as porcelain, fine firearms, toys, and various kinds of machinery. One of the most curious phenomena in imports is the considerable amount of English textile machinery that finds its way into America. Some foreign experts boldly say that we are behind the times in such equipment and still use methods and apparatus already discarded abroad. That such a condition actually does hold with respect to certain branches of engineering is only too true, but be that as it may, for some reason or other American makers of textile machinery have never been able to hold the whole home market.

Fine firearms and toys represent industrial antipodes, the former extraordinarily expert hand work, the latter very cheap labor acting with crude but effective labor-saving methods and inspired by exceptional ingenuity. High-grade firearms are made here, but in small quantities, the chief output being in the medium grades in which costly hand work is successfully replaced by the American method. The result is a wonderful fifteen or fifty dollars' worth of weapon, not quite equal however in finish and balance to the best work of the foreign armourers, so that English and German guns and rifles are found here in large numbers. Perhaps the existence of a well applied proof system in the former country is an element in the case.

And so the story goes on through a long line of articles which are made here only in a very limited way and are generally imported. Finally there are many grades of goods which can be and are made here for the home trade but which are supplemented by abnormally large importations. Many fabrics fall within this list, especially novelties of various sorts, together with a vast number of miscellaneous articles. The American method with its relatively standardized output and dislike of changing production is primarily responsible. But behind this lies a certain quality of shortsightedness, to which reference was made in the previous paper—a view which concerns itself only with the present fiscal year. There is the same tendency toward capitalization on an assumed maximum earning capacity in American manufacture as in American railroads, fortunately to a less degree and less generally. The desire for quick profits is of course world-wide and entirely proper, but it sometimes overreaches itself. In the long run the manufacturer who keeps in close touch with progress and is not afraid to vary his production to meet the world's needs will win out in the world's markets. He may have to content himself with less profits in some given year and reckon on squaring himself in another. A quarter-century, however, will even things up. So long as America has a rapidly expanding home market, and quantity of production is the only thing which limits profits, the present course goes on prosperously enough. It is the time of open competition with the world that will bring cause for anxiety.

In the engineering lines, for example, we are in the midst of a period of splendid prosperity. The home market keeps work going overtime, and behind orders at that. Meanwhile, outside the country, trade slips away from our disinclination to meet local conditions and methods. Even in electrical goods, of which we are large exporters, many a foreign contract goes against us to Continental makers even with difference of freight in our favor. Of course Continental labor costs in electrical works are only about half of those here, which makes competition difficult. Two other adverse factors however, are less necessary. It is difficult to get American makers to depart from their customary standards to suit foreign needs, and American capital, however bold at home, loses heart when it crosses the borders by land or sea. Valuable foreign franchises not infrequently go begging here and are promptly snapped up and made profitable by foreign capital. The same situation exists with reference to mining machinery and plants of various other kinds.

American methods in such cases suffer from their lack of flexibility. The acute desire to "standardize" everything renders us very slow to pick up manifest improvements, albeit when we do pick them up we often make better use of them than the originators. It is rather humiliating, for instance, to realize that nearly all recent improvements in electric lamps, both arc and incandescent, bear the foreign trademark, in spite of the fact that electric lighting is in the main of American origin. Similarly, in spite of all the country has done in the development of the steam engine American manufacturers are years behind the times in the use of superheated steam, likewise in the application of producer gas to serious work. There are one hundred and eighty German electric supply plants operated wholly by gas or oil engines and nearly as many more with such engines as auxiliaries.

No country can lead the world in improvements and at the same time confine itself to standard types. The present tendency here is such that the radical improvements in many lines are being made elsewhere. As a result the world markets are being won by others.

However effective our tariff may be in encouraging American manufacture in general, it is of small use in extending the foreign trade in the products of that manufacture, and every year the pressure of retaliation increases. If we ever are to regain the first place in active improvements it must be by taking advantage of prosperous times. When dull times come there will be little heart for large expenditure for experimenting along new lines. The kinds of manufacture in which America needs just now to be strengthened are the manufacture of high-grade goods now generally imported, and of goods especially suited to the needs of importing countries. The American method can take care admirably of the field it now fills, so long as foreign competitors with cheap labor do not really learn the game. The danger is that they will prove apt scholars, and by applying American labor-saving methods with the aid of labor already cheap, may gradually and steadily restrict the field in which Americans are now supreme. The remedy is not to shut one's eyes and declaim with patriotic pride of the continued prosperity of our industries, but to take up the march of improvement all along the line with something of the old swift alertness, and to prepare to meet the competition of the world in every grade of manufacture that its peoples demand.

THE SQUARE DEAL TO THE RAILROAD EMPLOYEE.

By H. W. Jacobs.

It is eight years since H. F. L. Orcutt, writing in these pages of a contrast in industrial policies at that time newly apparent, used the significant words: "It is economy as well as humanity to plan factories in which human life is of more account than machinery; into which human beings will not be driven by hunger, but attracted by superior hygienic surroundings—air, light, comfort—as well as by the most modern equipment for saving labor, increasing output, and raising the standard of workmanship and wages."

No one movement in the field of "Power and Production" during the intervening period is more striking than the progress of this concept in the belief and the practice of the foremost employers. We are glad that much of the current history of the advance has been written in THE ENGINEERING MAGAZINE. We are especially glad now to show so brilliant an example of its extension into a branch of engineering activity which sometimes has not been closely associated with the idea of care for the individual life. Mr. Jacobs' present article is a welcome demonstration that there are railway managers by whom the "square deal to the employee" is considered equal in importance to the increase of "efficiency in the railway machine shop."—THE EDITORS,

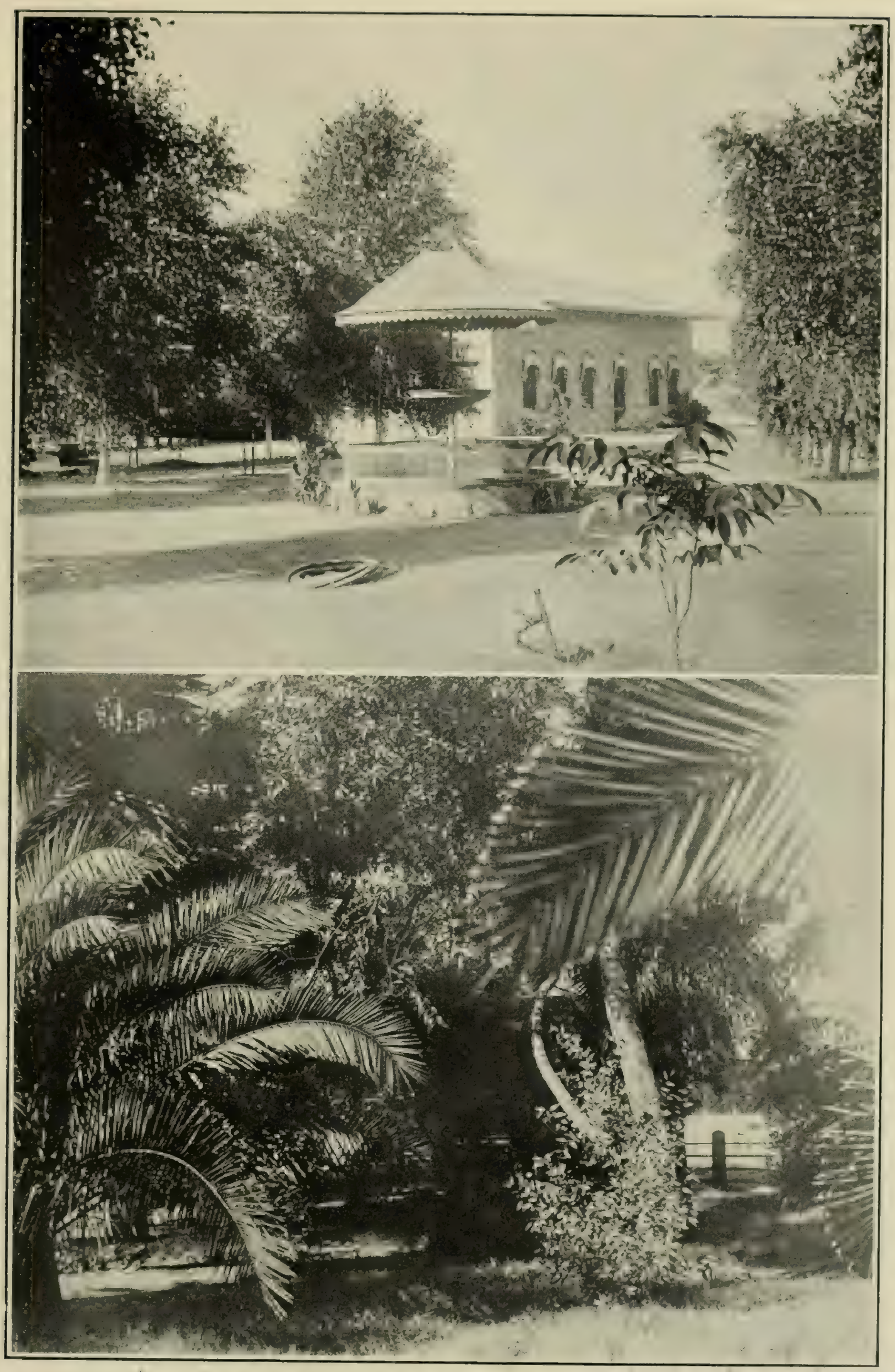
IN the September issue of THE ENGINEERING MAGAZINE, Dr. Louis Bell sounded a note of warning against the result of the American manufacturing method—devotion to securing the largest output of uniform character at minimum cost. He pointed out that this made automata out of the operatives and discouraged skilled, intelligent, and thoroughly trained artisans, to so great an extent that the quality of the men today was generally poor and unreliable.

Much of late has been written of the measures taken by manufacturing concerns to attract men of high character to their employ—to surround their men with an environment making toward integrity, sobriety, and industry, and not only to make the lot of the workmen a more agreeable one, but to reward him in proportion to his efforts as well, in order to avoid the evils of "the American tendency." Although less has been written regarding their treatment of employees, some of the railroads have been doing a work along these lines unequalled in depth of motive and breadth of application.

E. P. Ripley, president of the Santa Fe system is quoted in the Chicago Record-Herald of January 5, as saying:

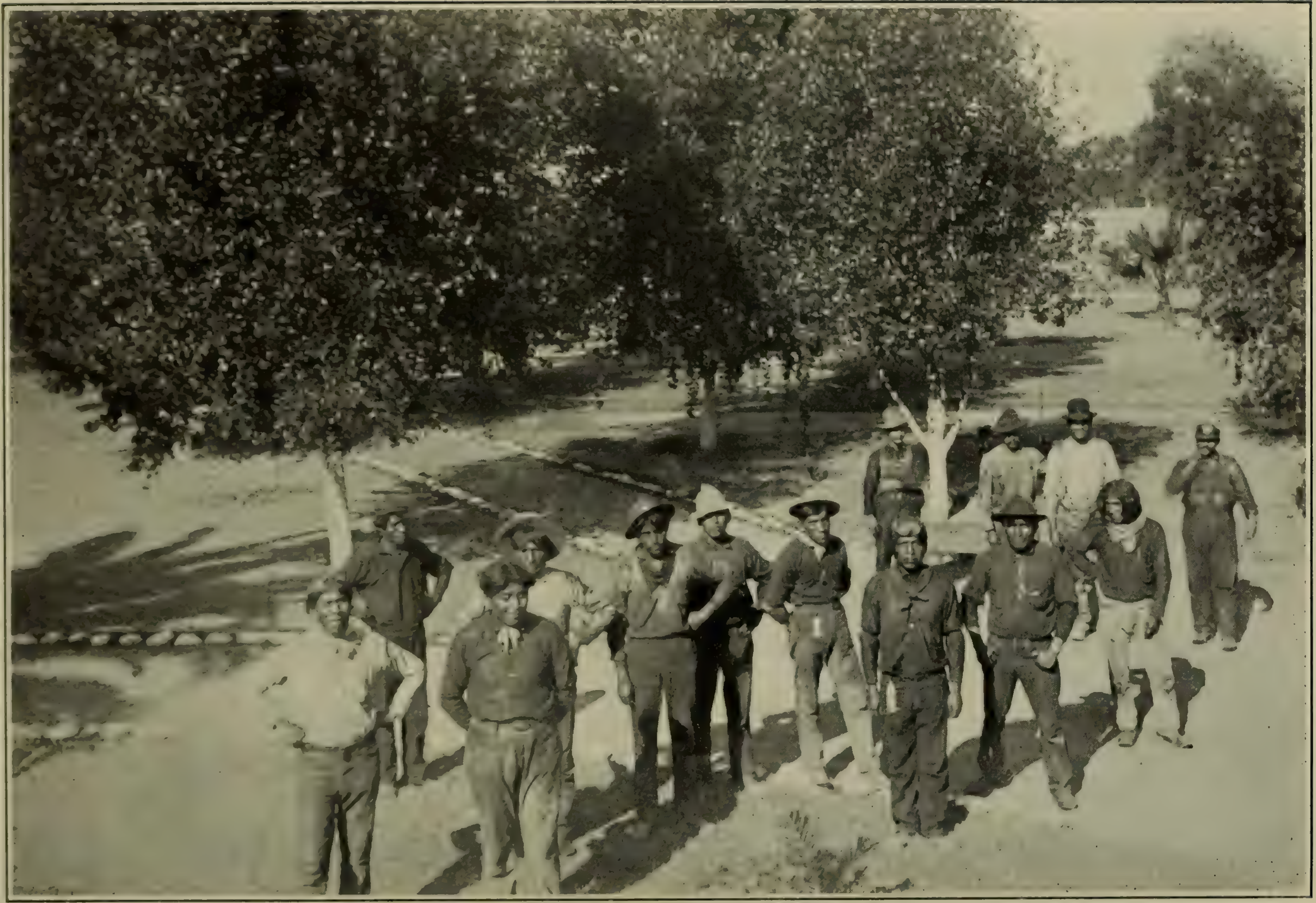
"One of the most serious conditions which this country is facing today is the indifference and the disregard which the employee has for the interests of the employer.

"The Santa Fe," continued Mr. Ripley, "hopes to establish a bet-



EXAMPLES OF SANTA FE METHODS IN MAKING AN ATTRACTIVE ENVIRONMENT FOR THEIR EMPLOYEES.

The upper view is of the shop yards and offices at the Needles; the gold-fish basin has an umbrella cover to protect the fish from the glaring sun. The lower view is of a station park at a desert point.



A GROUP OF MOJAVE INDIANS, EMPLOYED BY THE SANTA FE AS WIPERS, SWEEPERS, AND HANDY MACHINISTS.

TYPICAL READING ROOMS, PROVIDED BY THE SANTA FE ROAD FOR EMPLOYEES.
The upper one is in Arizona, the lower at Richmond, Cal. There are others at La Junta, Col., at Raton, N. M., and elsewhere—about twenty altogether.

ter *esprit de corps* among its employees, and expects that a liberal pension system will have this tendency. We have on this system as much loyalty as most railroads enjoy, if not more, but it is not what it should be. The lack of loyalty among employees is a condition from which all corporations are now suffering, and it presents a most serious problem."

Railroads are the pioneers of civilization and commerce in America; they pierce mountains, blaze a way through the forest, and establish a highway through the arid plains and the desert regions of the south-west. They are antennae or feelers, through which human society reaches out and extends its domain over untrammeled nature.

THE NEW RECREATION HALL FOR EMPLOYEES ERECTED BY THE A. T. & S. F. RAILWAY AT THE NEEDLES, CALIFORNIA DESERT.

The hardy and adventurous, the bold and the wild, among our race, become prospectors, miners, ranchers or settlers, or they serve the railroad which serves all. This life, hard and rough, encourages the lawless and incubates the saloon and attendant social evils. It was hardly uncommon in a frontier town to find every third house a saloon, and to their temptations the railroader, because of his extremely unsettled and nervous life, is especially subject. For instance, in one desert town there used to arrive each month on pay-day morning, from a large Pacific Coast city about twelve-hours distant, a number of detrimentals and gamblers who spent the next few days shearing their victims.

To combat the evils of the saloon

DIVISION OFFICES AT THE NEEDLES, SHOWING WIDE PORCHES AND EAVES FOR PROTECTION FROM THE DESERT HEAT.

and to encourage men of the superior class, with families or without, one Western road, the Santa Fe, has gone extensively and expensively into the construction and maintenance of reading rooms, recreation halls, hospitals and company cottages, and of parks and pleasure grounds around the stations, shops, and offices.

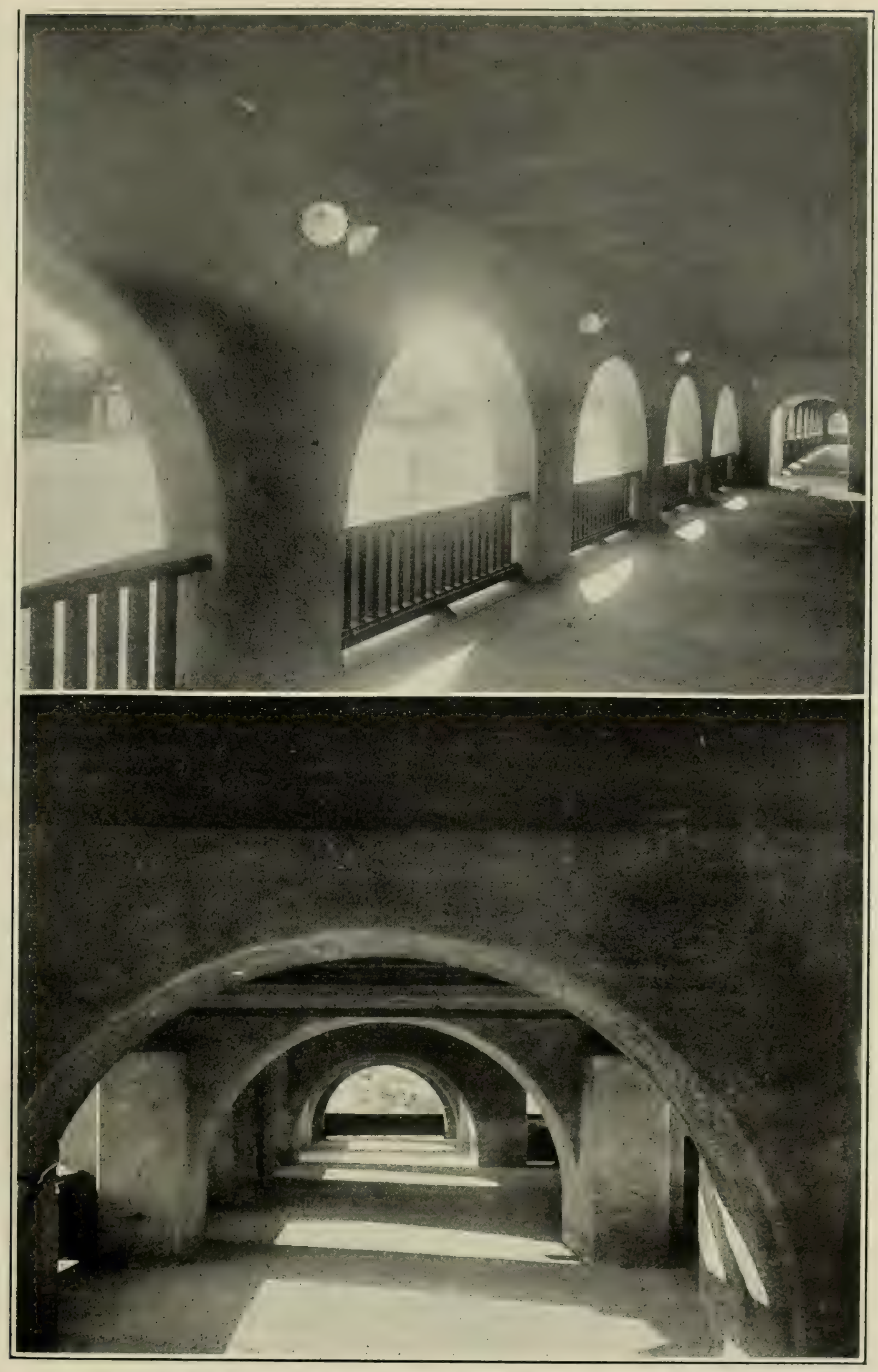
A station called the "Needles," on the banks of the lower Colorado river, in the heart of the Arizona-California desert (the haunt of the Mojave Indian) about one hundred miles southeast of Death Valley,

READING ROOM FORMERLY AT THE NEEDLES, CALIFORNIA.
Replaced by the fine structure shown on the page opposite and in following pictures.

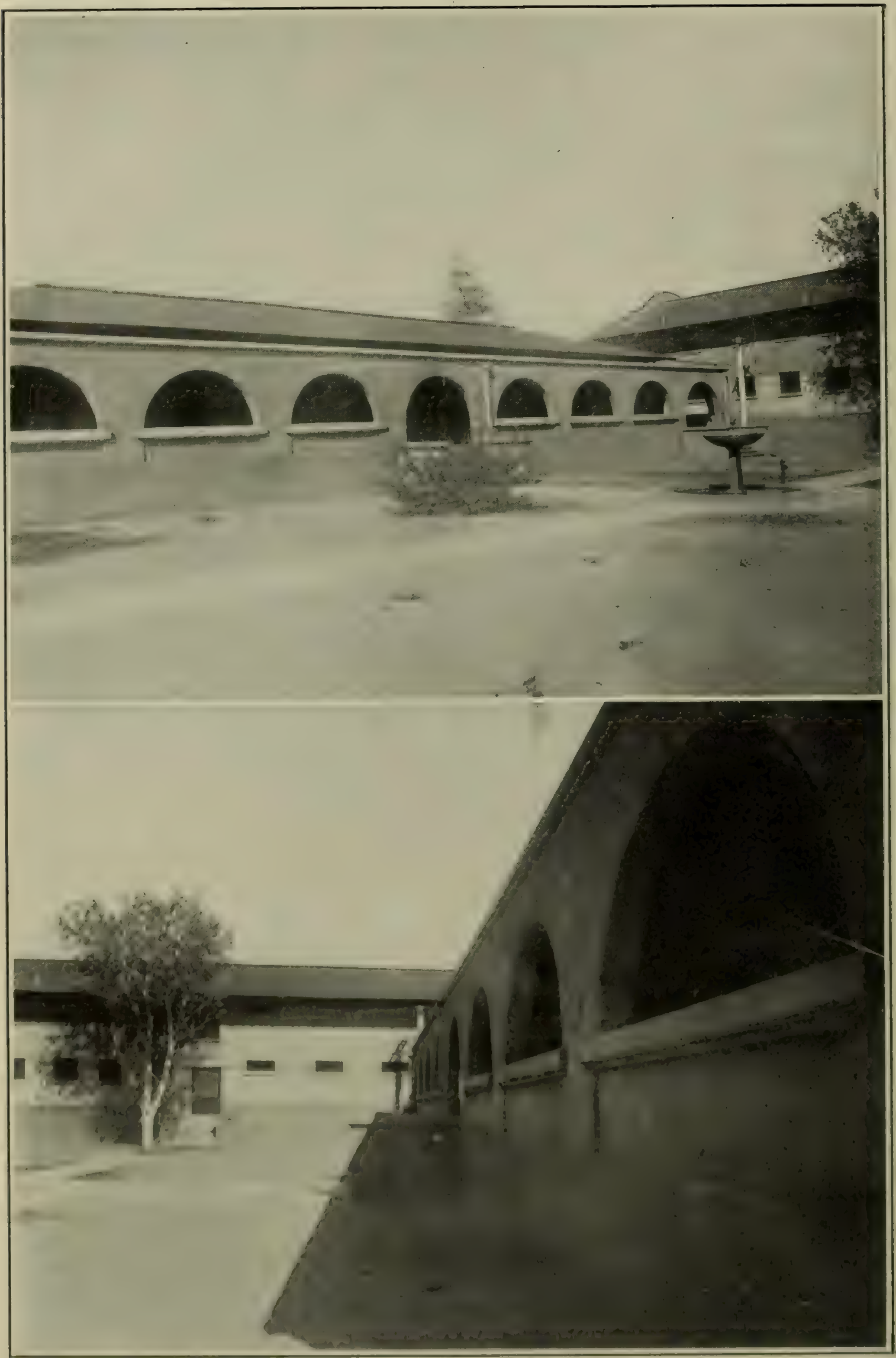
PORTAL OF THE SANTA FE RECREATION HALL AT THE NEEDLES.

being a shop and division point, was typical of severe conditions. It was said that the railroader's experience was not complete until he had spent some time there; that a machinist who could hold on for three months would be promoted to master mechanic. The summer heat is intense, yet notwithstanding these severe conditions the climate is salubrious, and in winter, ideal.

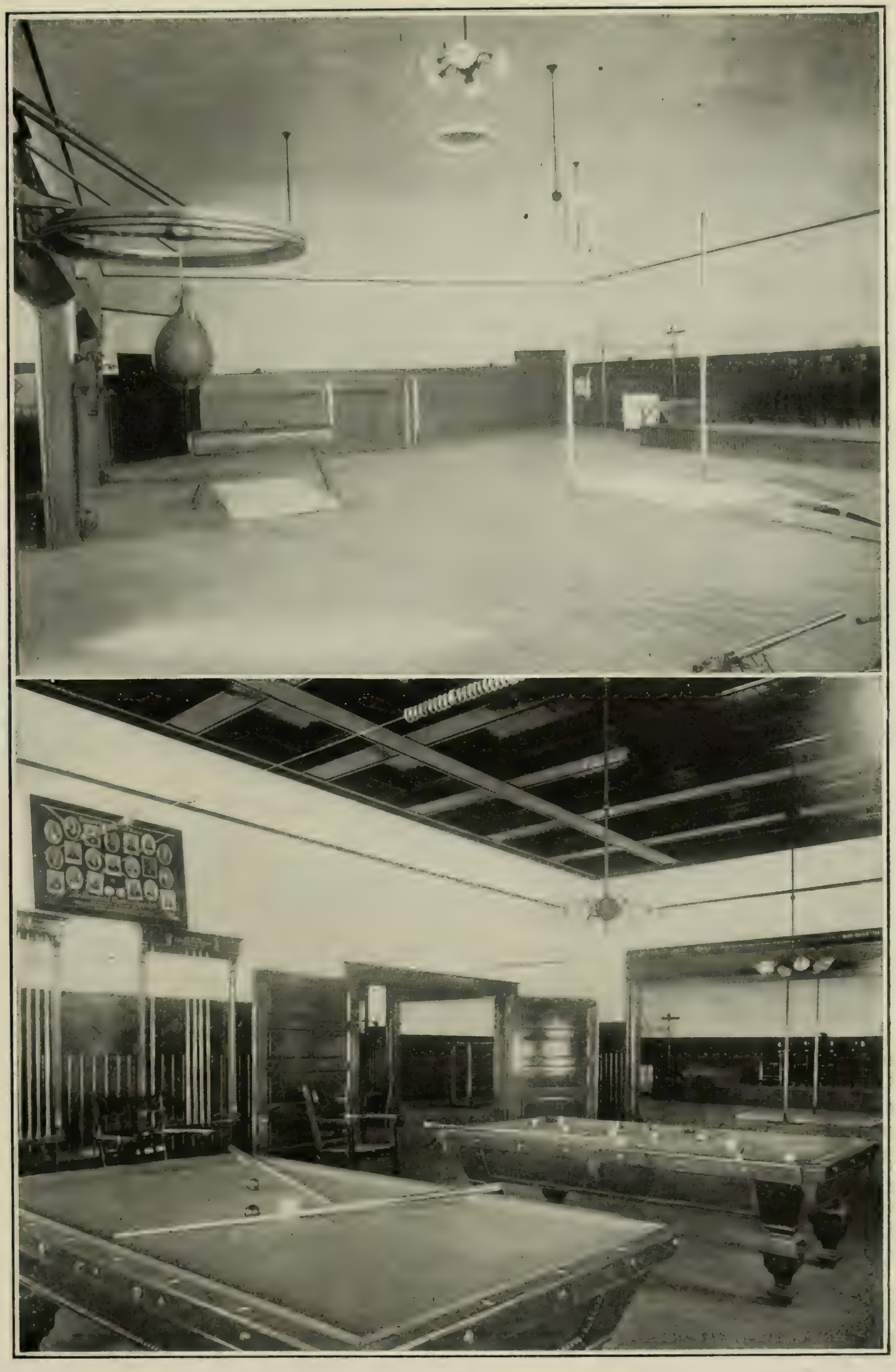
The company has built at this point, without regard to expense,



IN THE NEEDLES RECREATION HALL. THE UPPER VIEW IS THE WEST PORTICO; THE LOWER IS THE UPPER VERANDA AND ROOF GARDEN.



TWO VIEWS OF THE INNER COURT AND FOUNTAIN, THE SANTA FE RAILWAY'S RECREATION HALL FOR EMPLOYEES AT THE NEEDLES, CAL.



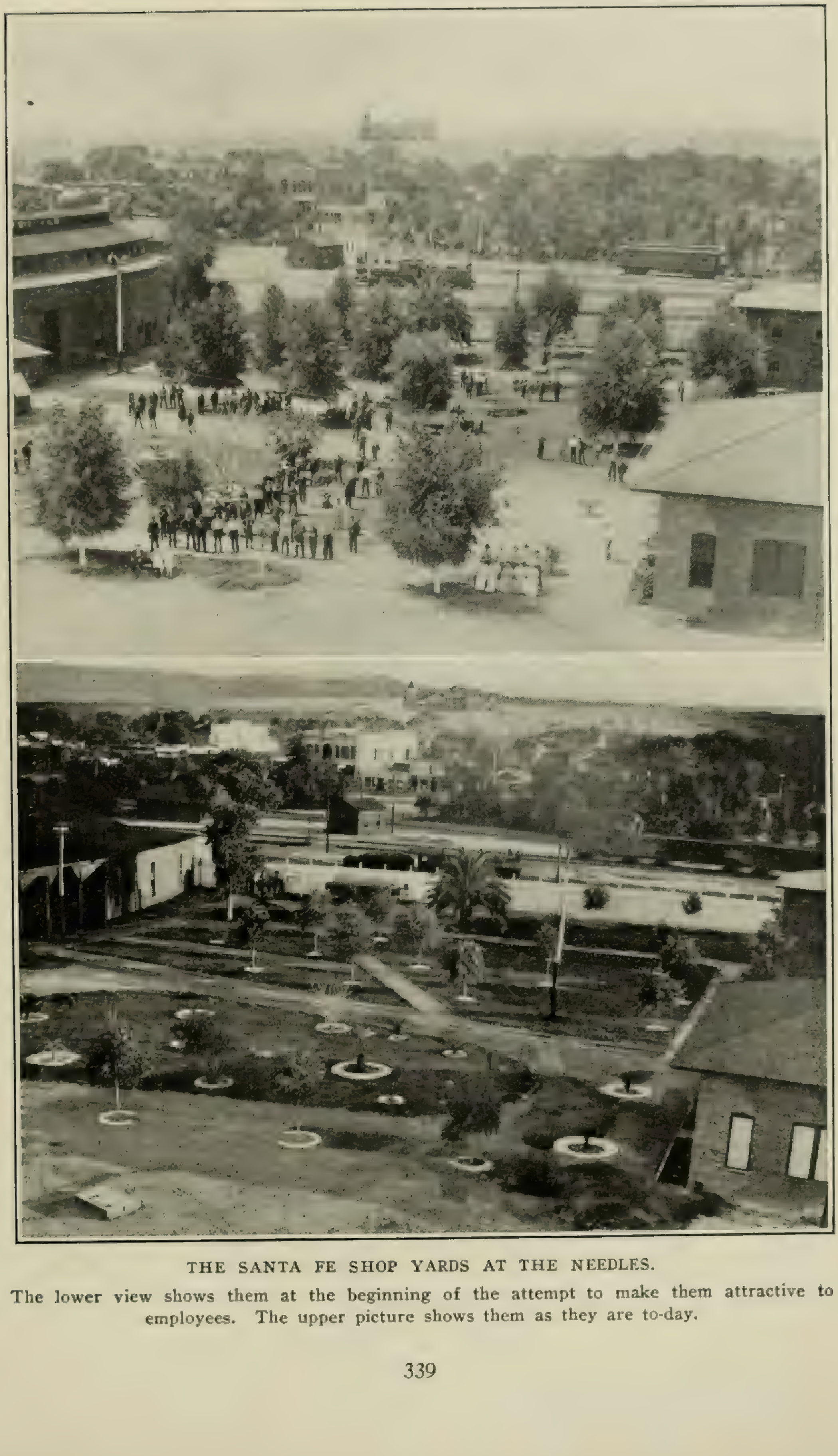
GYMNASIUM AND BILLIARD ROOM, NEEDLES RECREATION HALL.

one of its finest recreation halls, in the Mission style; a hospital is maintained, parks have been grown, the shop grounds have been beautified, and cottages have been built. At other points where the conditions are severe, similar measures have been taken, as at Winslow, Arizona, and at La Junta, Colorado.

SWIMMING POOL, THE NEEDLES RECREATION HALL.

In all the principal cities along the railway, hospitals are maintained; each employee, from laborer to the higher officials, pays a small monthly sum (from 25 cents to $1.00) to the hospital association, the aggregate amounting to about $20,000 a month. Some of the trustees of the association are officials of the company, while others are employees. These trustees devote any surplus receipts over expenditures to permanent improvements, new buildings, and additional facilities. Although in this respect self-supporting, this association has received much substantial aid from the railroad in the way of donations to building funds, company buildings rent-free, and other services. All officers and employees of the association, including surgeons, receive transportation free while in the company's service, the same rule applying to injured and sick employees.

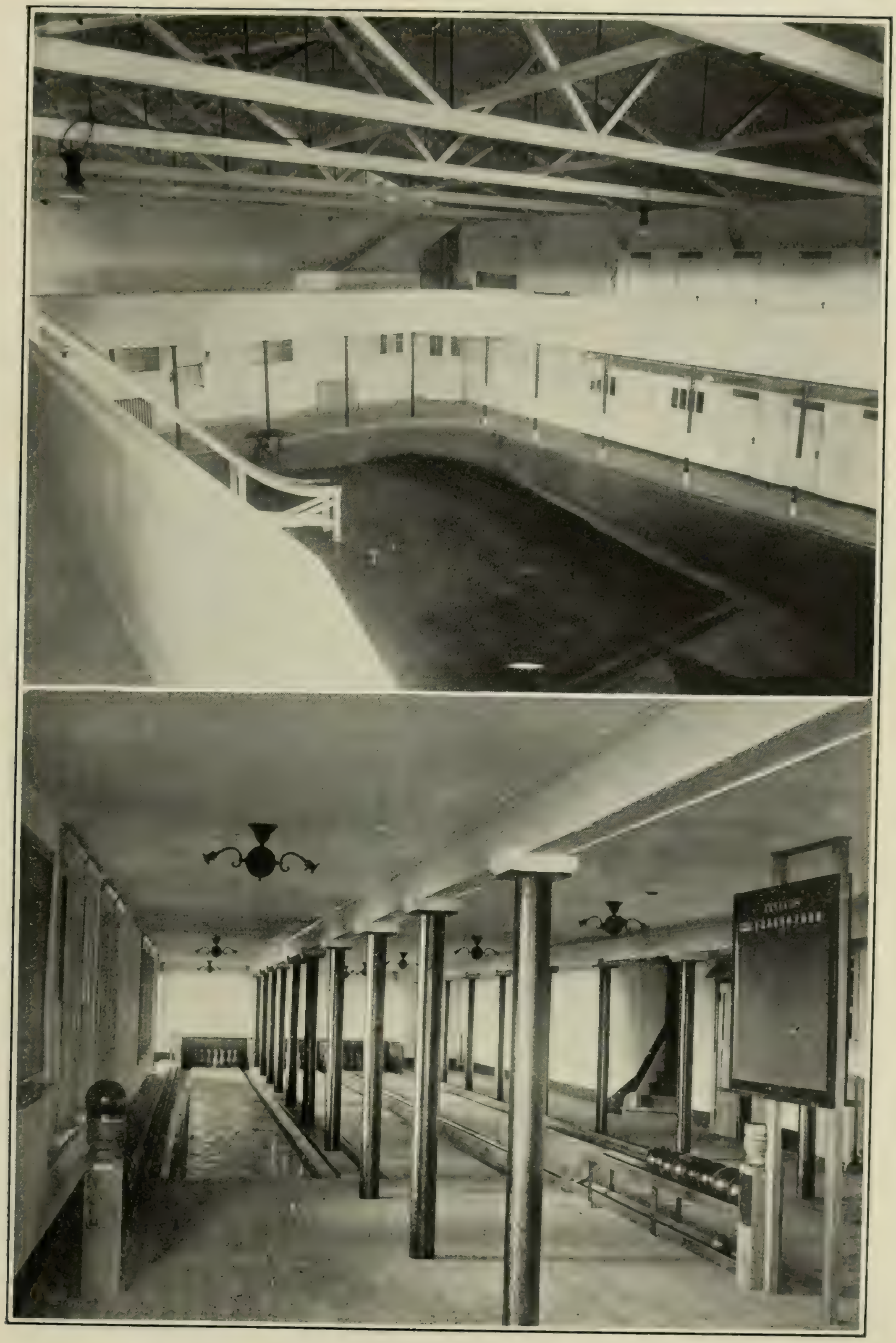
The most notable hospital is at Topeka, where the chief surgeon has his staff of five surgeons, about thirty nurses, and many other employees. At this point from fifty to one hundred patients are in the various wards all the time, not only for injuries received, but also for



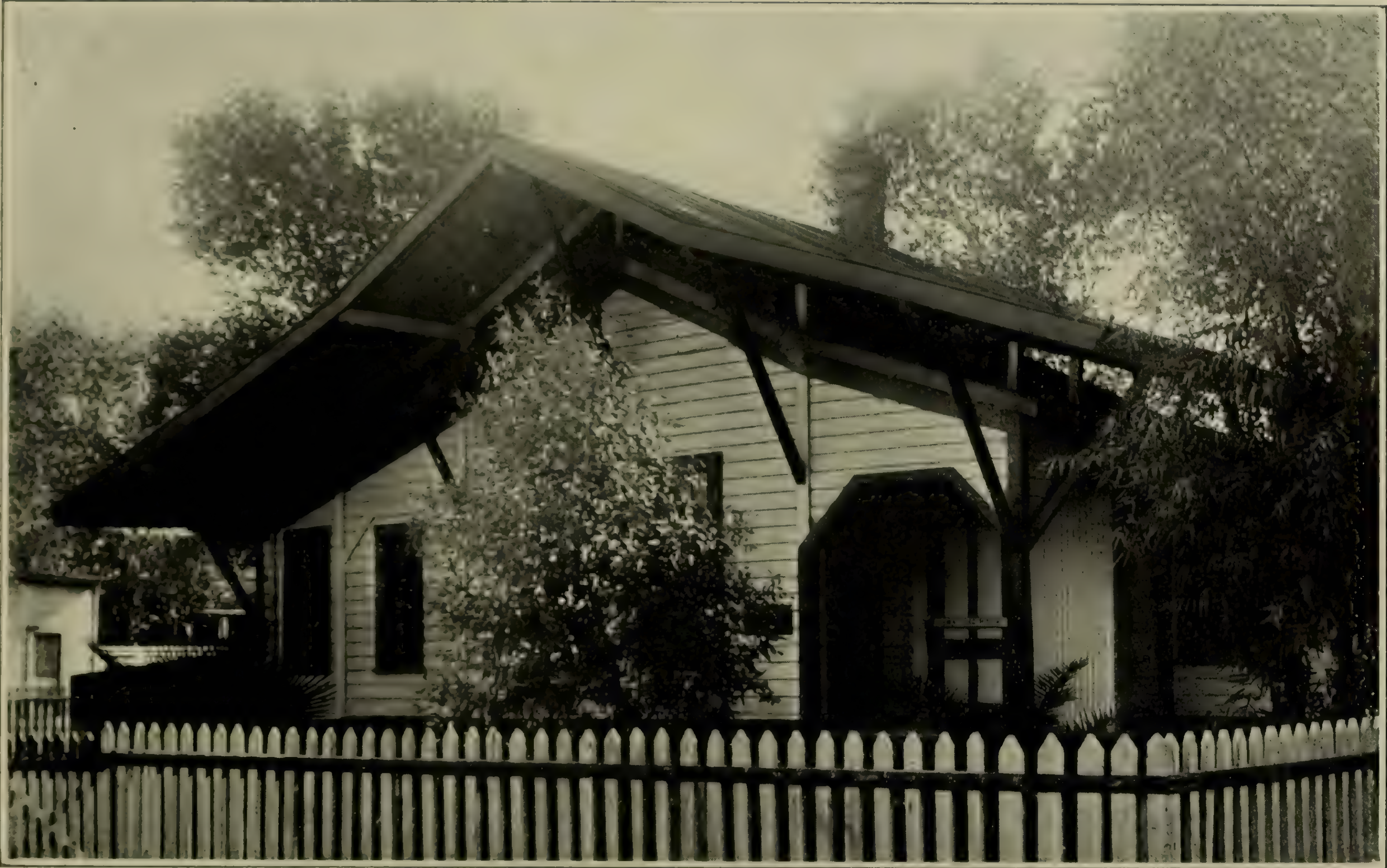
THE SANTA FE SHOP YARDS AT THE NEEDLES.

The lower view shows them at the beginning of the attempt to make them attractive to employees. The upper picture shows them as they are to-day.

THE WRITING ROOM AND THE READING ROOM IN THE NEEDLES RECREATION HALL.



THE SWIMMING POOL AND THE BOWLING ALLEY, NEEDLES RECREATION HALL.



TEMPORARY HOSPITAL AT A DESERT POINT. THE DOUBLE ROOF IS DESIGNED TO ALLOW FREE CIRCULATION OF AIR.

MAIN BUILDING, A. T. & S. F. RAILWAY HOSPITAL ASSOCIATION, TOPEKA, KAS.

sickness. Many serious operations are of course performed. There are many private rooms for severe or special cases. The other hospitals render service similar to that at Topeka, there being about a dozen at various points on the road. Besides these hospitals, which aim to take care of all the cases in their own territory, there are several hundred physicians and surgeons who devote all or part of their time to the company's service at various towns of any size on the road.

In the principal cities ambulance service is provided; in the grounds of the larger shops there are emergency rooms, and in each shop department are men instructed in the "first aid to the injured," regular classes being held at the company's hospital.

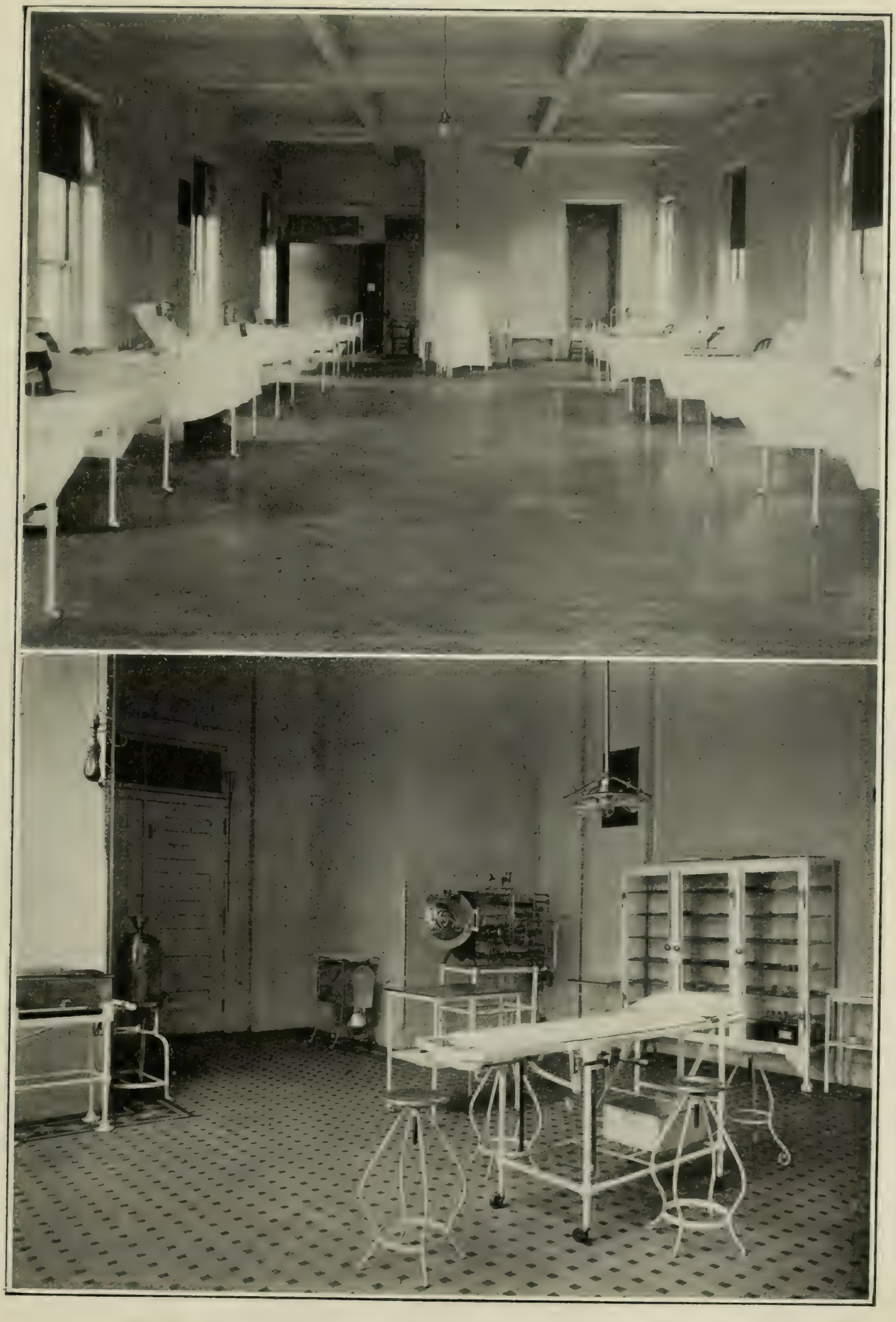
Other railroads carry on the same kind of good work, and the time will not be far distant when it is generally recognized that the railroad management, their employees, and the public, have common interests stronger than any differences.

These examples of the interest of the railroad for its employees are not along the line of paternalism, but are in the nature of an investment in the character, health and good-will of the employees.

ISOLATED WARD IN THE SANTA FE HOSPITAL, TOPEKA.

Another advantage that has been instituted is the pension system, and still another of no small importance is the advantage of the employees to get free transportation for themselves and family from time to time.

The pension system is one of the latest institutions established by the company, and while modeled on pre-existing examples, it has been introduced in the belief that its terms are more liberal than those of any pension plan previously enforced. It is carried out wholly at the expense of the company, but under the conviction that the employees will show appreciation of it by increased zeal and loyalty. Nearly every employee has it in his power to benefit his employing company by the character of his work and his influence, or to injure it by carelessness or indifference. The establishment of the pension is based upon confidence that those whose future is thus made safer will in return render the best service of which they are capable.



WARD AND OPERATING ROOM, SANTA FE HOSPITAL, TOPEKA.

NURSES' PARLOR AND REST ROOM, AND DINING ROOM FOR CONVALESCENTS, SANTA FE HOSPITAL, TOPEKA, KANSAS.

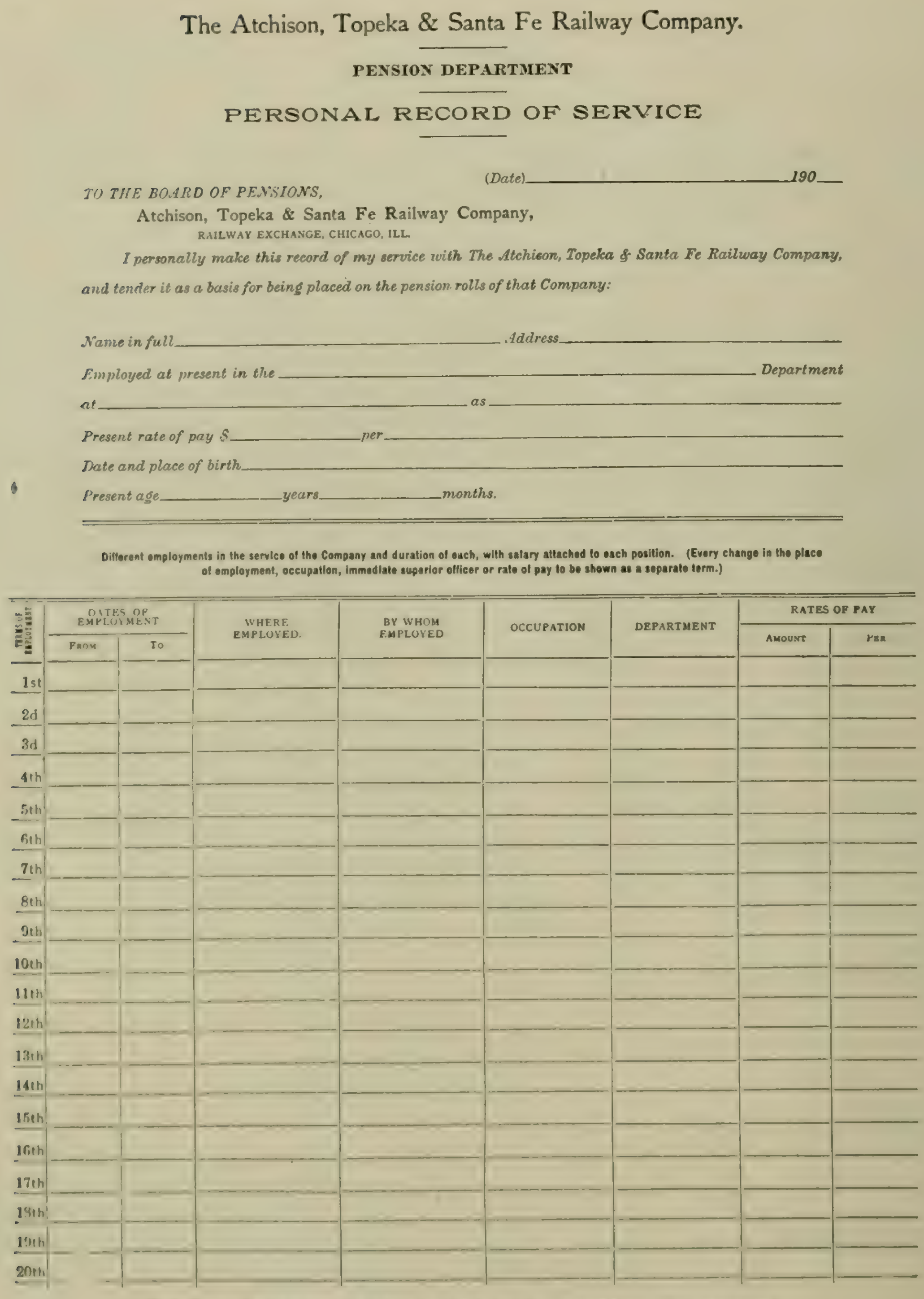
The general management of the pension system is in the hands of a board of five officers or employees designated by the president of the railway, and acting under his general direction and during his pleasure. This board adopts its own rules, subject to revision by the board of directors or by the president of the railway company.

THE RAILROAD Y. M. C. A. BUILDING, TOPEKA, KAS.

Pensions may be granted to any retired officer or employee who has served the company continuously for fifteen years or more preceding the date of his retirement, and who, at the time of retiring, has reached the age of 65 years, or who for any cause incident to his employment has been permanently incapacitated for the performance of his regular duty and who cannot be transferred to other work which he is still able to perform. Under this provision the construction is liberal, for in the case of employees of roads leased or purchased the period of service of the employee is construed to date from the time when he entered the employment of the road acquired, and not merely from the time when that road may have passed into the control of the main system.

Further, pensions may not be withheld nor revoked simply because the recipient may have other means of support or may be engaged in other business, if that business is not prejudicial to the interests of the corporation or its auxiliary companies; but the pension board may deny, revoke, or withhold, a pension allowance to any employee if he prove himself wholly undeserving through immorality or other misconduct.

Pensions are not allowable, further, if the officer or employee has made or enforced any claim for damages against the company for injury or accident occurring within three years of the time when the



The Atchison, Topeka & Santa Fe Railway Company.

PENSION DEPARTMENT

PERSONAL RECORD OF SERVICE

(Date)________________ 190__

TO THE BOARD OF PENSIONS,
Atchison, Topeka & Santa Fe Railway Company,
RAILWAY EXCHANGE, CHICAGO, ILL.

I personally make this record of my service with The Atchison, Topeka & Santa Fe Railway Company, and tender it as a basis for being placed on the pension rolls of that Company:

*Name in full*________________ *Address*________________

*Employed at present in the*________________ *Department*

*at*________________ *as*________________

*Present rate of pay $*________ *per*________________

*Date and place of birth*________________

*Present age*________ *years*________ *months.*

Different employments in the service of the Company and duration of each, with salary attached to each position. (Every change in the place of employment, occupation, immediate superior officer or rate of pay to be shown as a separate term.)

TERMS OF EMPLOYMENT	DATES OF EMPLOYMENT		WHERE EMPLOYED.	BY WHOM EMPLOYED	OCCUPATION	DEPARTMENT	RATES OF PAY	
	FROM	TO					AMOUNT	PER
1st								
2d								
3d								
4th								
5th								
6th								
7th								
8th								
9th								
10th								
11th								
12th								
13th								
14th								
15th								
16th								
17th								
18th								
19th								
20th								

FORM FOR PENSION APPLICATION AND RECORD OF SERVICE.

applicant is retired or leaves the service. Neither are they allowable if, during the fifteen-year period, an applicant has been engaged in business or employment other than the service of the company. The fifteen years must be continuous, and voluntary withdrawal for two months or more is sufficient to constitute a break; but leave of ab-

The Atchison, Topeka & Santa Fe Railway Company.

PENSION DEPARTMENT

TO THE BOARD OF PENSIONS:

.... who has been .... years continuously in the service of the A. T. & S. F. Ry. Co. and is now employed as ....

at .... on the .... 1 ...., reached the age of 65 years and under the provisions of the Pension System may be retired from service. The following statements respecting h........ are submitted for the information of the Board of Pensions:

[HERE SHOULD FOLLOW A STATEMENT OF THE EMPLOYE'S MENTAL AND PHYSICAL CONDITION AND AN EXPLICIT RECOMMENDATION FOR RETIREMENT OR FOR CONTINUANCE IN THE SERVICE.]

....

....

....

....

....

....

....

[IF RECOMMENDED FOR RETIREMENT GIVE CAREFULLY CONSIDERED STATEMENT OF CHARACTER OF SERVICE RENDERED]

....

....

....

....

Does employe desire to be retired? ....

Date when last on duty if now disabled ....

Date to which wages were paid if now disabled ....

Signature .... Official Title ....

Date .... Location ....

Respectfully forwarded to .... (Date) ....
who is my immediate superior officer.

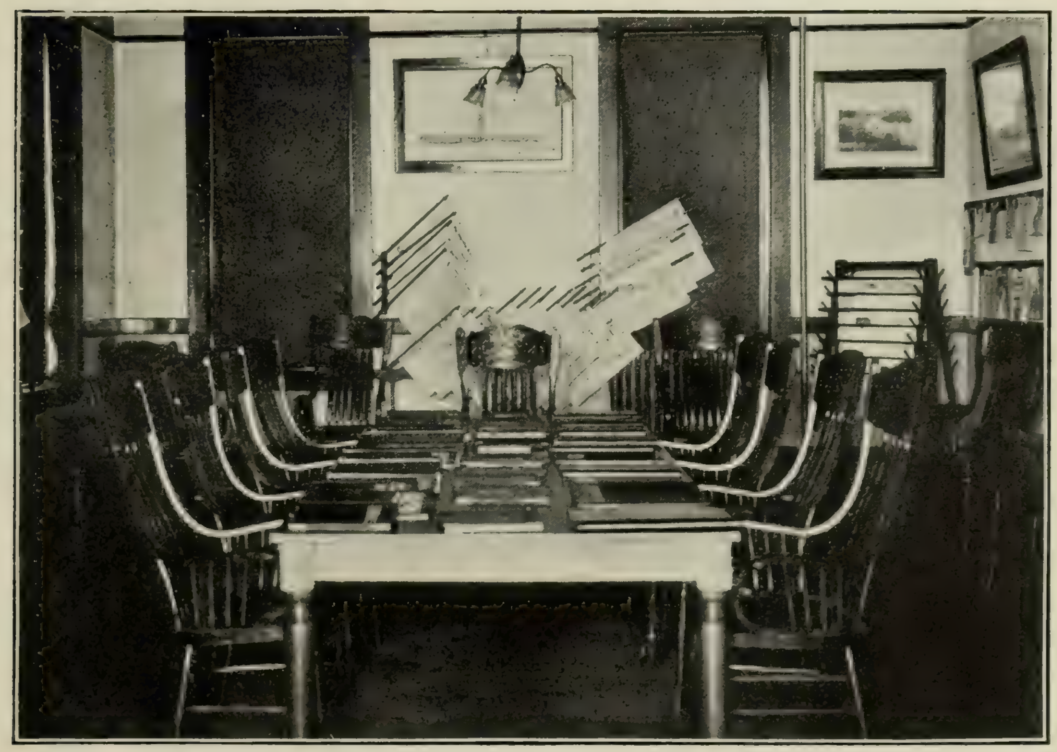
FORM FOR RECOMMENDATION OF AN EMPLOYEE'S PENSION APPLICATION.

sence duly granted, or even suspension or dismissal if followed by reinstatement within one year, are not regarded as interrupting the continuity of service.

The amount of the pension is contingent upon three elements: (1) the highest average monthly pay received by the pensioner during

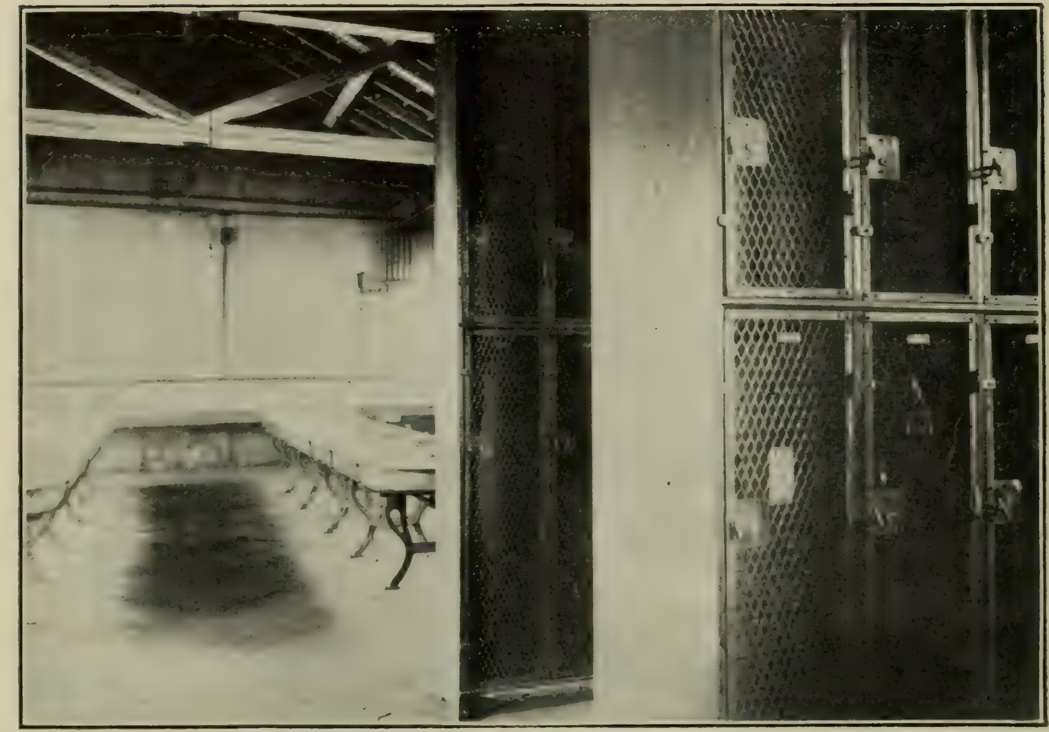
A WIRE-SCREENED BUNGALOW FOR A "BACHELOR" MASTER MECHANIC, SANTA FE RAILWAY.

any consecutive ten years of service; (2) the number of years he has been in the employment of the company or its auxiliary companies; (3) the character of the service he has performed. The general rule is that employees whose highest average monthly wage during any consecutive ten years was $50 or less may receive 1¼ per cent of this monthly average for each year of service, while employees whose pay exceeded $50 per month may be granted for each year of service 1¼ per cent on the first $50 and ¾ of 1 per cent on the remainder. A minimum of $20 a month and a maximum of $75 per month are, however, arbitrarily provided. If the pension computed as above falls below the lower figure it is raised to $20, and if it rises above the higher figure it is reduced to $75. In case of exceptionally long and unbroken service with a first-class record, the board of pensions, with the approval of the president, may increase by as much as 25 per cent any pension as calculated under the preceding rule, provided always that the total sum paid does not exceed $75 a month.



READING ROOM IN THE RAILROAD Y. M. C. A., TOPEKA, KANSAS.

Application for pension is made by filling out a blank, of which reproduction is given on page 348. The signature of the employing officer must be secured in approval, and the application is then passed to the board of pensions through its secretary. In addition to the information called for in the application form the board may ask



SANITARY WASH AND LOCKER ROOM, SANTA FE SHOPS, TOPEKA.

for any further particulars it thinks necessary, and may require a physical examination by the company's surgeon, where the retirement is asked on the ground of incapacity. The acknowledgement of the receipt of the application and notice of the action taken upon it is communicated to the applicant through his employing officer.

The resolution of the board of directors adopting the pension system sets forth that it has been instituted "in order to enable the employees of the company who have rendered long and efficient service to retire when advanced age makes relief from work desirable." This sense of security in old age or in disability incurred in service has proved elsewhere to be one of the greatest incentives to loyalty, contentment, and faithfulness in service. It has as yet found comparatively little application in industrial management in the United States.

By the institution of the system the Santa Fe road seems to be taking a long step toward the betterment of permanent relations between employer and employed. The probability that it will be fully justified and repaid by the results does not diminish in the least the credit due to the far-sightedness and the praiseworthy effort of those who are responsible for its introduction.

HYDRO-ELECTRIC POWER VERSUS STEAM FOR INDUSTRIAL PLANTS.

By H. von Schon.

III. TYPICAL MODERN STATIONS AND OPPORTUNITIES INVITING DEVELOPMENT.

In an initial article appearing in the April issue of The Engineering Magazine, Mr. von Schon drew a comparison and contrast between hydro-electric power and steam in point of availability, efficiency, and cost. A second installment took up the method of making a commercial study of a water-power proposition. In this third paper the treatment is very concrete. Three characteristic plants of widely varying types are described as examples of what has been done, and a list of about fifty as yet undeveloped water powers is appended to show the wealth of opportunities ready for improvement. A concluding article next month will review the engineering study necessary in examination of a project of this kind.—The Editors.

IN offering descriptions of hydro-electric plants I have selected three of the more recent developments, representing distinctly different programmes and some of the latest hydro-electric structural types.

One of the largest low-head water-power developments was completed four years ago at Sault Ste. Marie, Mich., at the lower end of Lake Superior, abreast of the Sault Ste. Marie rapids. The contributing drainage area contains about 50,000 square miles, of which the lake covers 30,000, the normal annual precipitation over this area being 30 inches; the monthly outflow of Lake Superior fluctuates between 58,000 and 120,000 cubic second feet, the lesser volume prevailing during the frozen period. The fall represented by the Sault rapids varies from 19 to 20 feet in accordance with the upper and lower stages; the normal level above the rapids is at elevation 601.5 feet, and that at foot of rapids is 582.0 feet.

The International boundary line lies somewhere in the rapids; its definite position is unknown, and the waters are theoretically divided between the United States and the Dominion of Canada.

The Sault Ste. Marie River, which should be more properly called a "strait," connects Lakes Superior and Huron and is navigable, the rapids being passed by means of the largest locks in existence; both Governments exercise control over the waters in the river and the rapids, and the title to two islands is in dispute. Large quantities of logs pass out of Lake Superior by way of the rapids, the use of

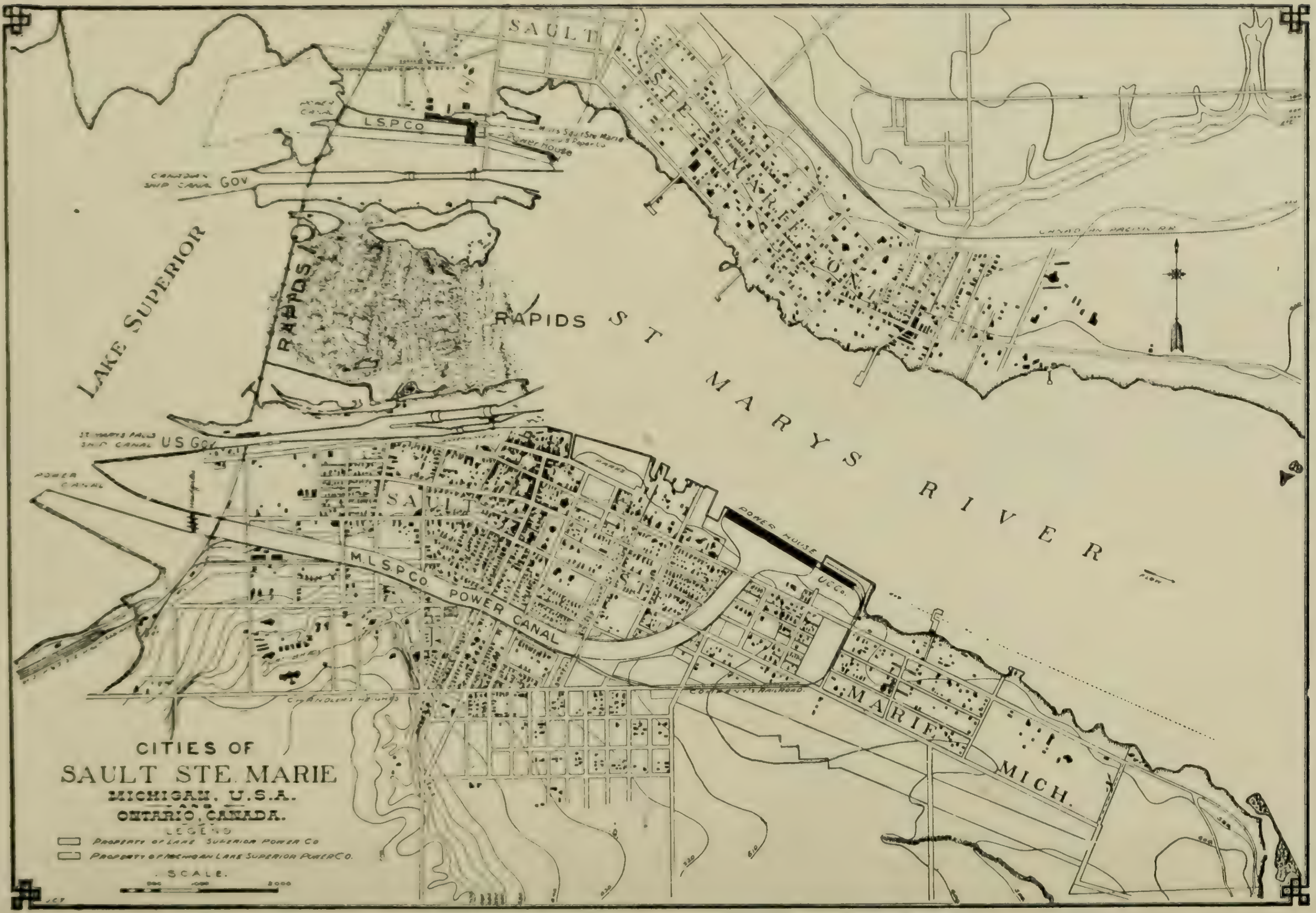


FIG. 1. GENERAL MAP OF THE SAULT SHOWING THE TOPOGRAPHICAL RELATIONS OF THE MICHIGAN-LAKE-SUPERIOR POWER COMPANY'S UNDERTAKING.

the locks not being available for this purpose, and the important interests of Lake shipping are readily affected by even a slight lowering of Lake Superior level beyond the natural fluctuations. These facts are cited because each one of them proved of importance in the consideration of the development programme.

It does not require an expert to conclude, after general preliminary examination of the physical conditions, that the simplest and most economical development plan at that point consists of constructing a spillway across at the foot of the rapids, connecting it to shore embankments, and passing the flow through turbines placed within the spillway or in stations at its ends; but a casual survey of the conflicting conditions of control and ownership on these rapids suffices to negative such a programme. Diversion of the flow around the rapids was the only solution.

The city is built along the river shore, back to a range of hills; the Government canal extends half a mile above the rapids, and the locks and Government docks for a like distance below; the location of the diversion canal was therefore of necessity through the heart of the city; its intake was determined above the Government canal entrance, and the terminal below the Government docks. This was an exceedingly costly plan as compared with the logical one in the rapids, the canal being some 2½ miles long, 300 feet wide, and its cuttting from 30 to 35 feet deep, more than a mile of it through Potsdam sandstone ledge; the cost of this canal alone was about five times that of the probable cost of a dam across the rapids. The sandstone hogback which here crosses the river drops immediately below the rapids to a depth of 50 feet and more, and thus the terminal of the canal and the dam and power house, necessarily located there, had to be placed on pile bearing foundations, which added largely to their cost. Adverse criticisms have been freely passed upon the development as carried out, but evidently their authors were ill informed as to the conditions which forced it upon the power company and the designer.

Figure 1 shows the location and development, in which the conditions just described will be readily recognized.

The flow capacity of the canal is 30,000 second feet; its prism, where passing through rock, is rectangular, and in the other section trapezoidal; near its terminal the forebay is located, and is closed by the power house, the sub-structure of which forms the dam; this structure is 1,368 feet long, paralleling the river shore. The water passes through the power house into the river one-half mile below the rapids, the effective head being 18 feet.

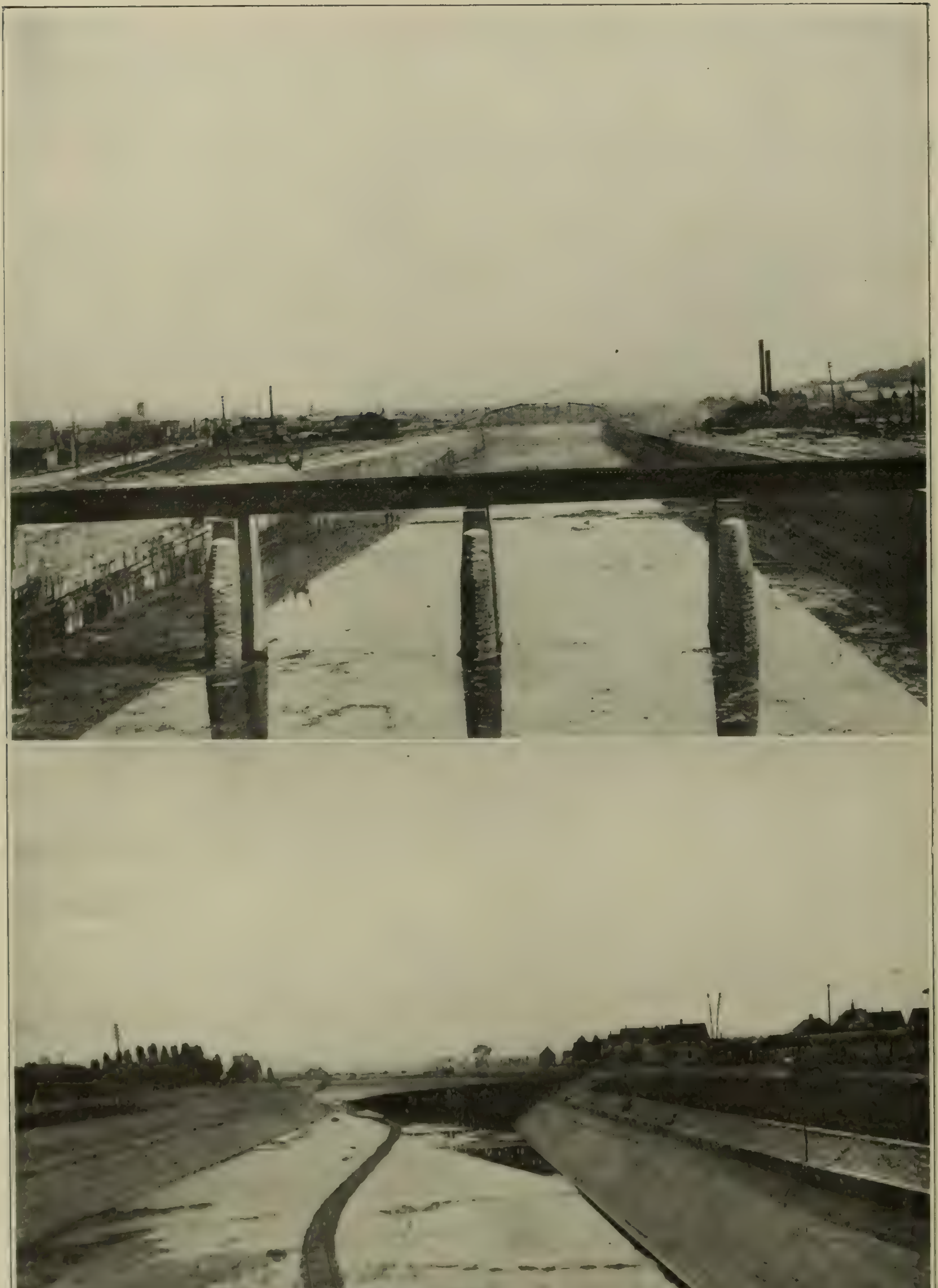


FIG. 2 AND 3. TWO VIEWS OF THE CANAL, THE UPPER IN ROCK AND THE LOWER IN EARTH SECTION.

The construction of all works is of the best for the purpose; the rock canal prism is channelled, the earth section is timber-lined throughout, the upper slopes are paved; Figures 2 and 3 are representative of these. The forebay is of same construction as canal, being timber-lined and floored, and across its throat is placed an intercepting rack, which appears on page 361 looking toward the power house. This latter is the largest structure of its kind, its length exceeding a quarter of a mile; it rests upon a timber grillage and concrete foundation supported by some 12,000 piles driven to rock. This is probably one of the first structures in which concrete blocks were used instead of shaped stones for ashlar masonry walls; these blocks, about 8,000 in number, were generally 3 by 3 by 5 feet, formed with tongues and grooves, as appears in Figures 5 and 6. All the substructure was so built; it consisted of 81 chambers—pits—enclosed at three sides by walls of these blocks, as shown in Figure 5, the up-stream closing wall being of the same material but arched. Concrete-steel practice was in its infancy in 1898, but more of it was placed in the Sault power house than in any other single structure since; the pit roofs are concrete-steel arches; the 81 penstocks, or turbine chambers, placed upon the pits, are separated by concrete-steel partitions, and the mill floor above the penstocks, 1,296 feet long and 85 feet wide, consists of 81 concrete-steel arches of 16-foot spans. The

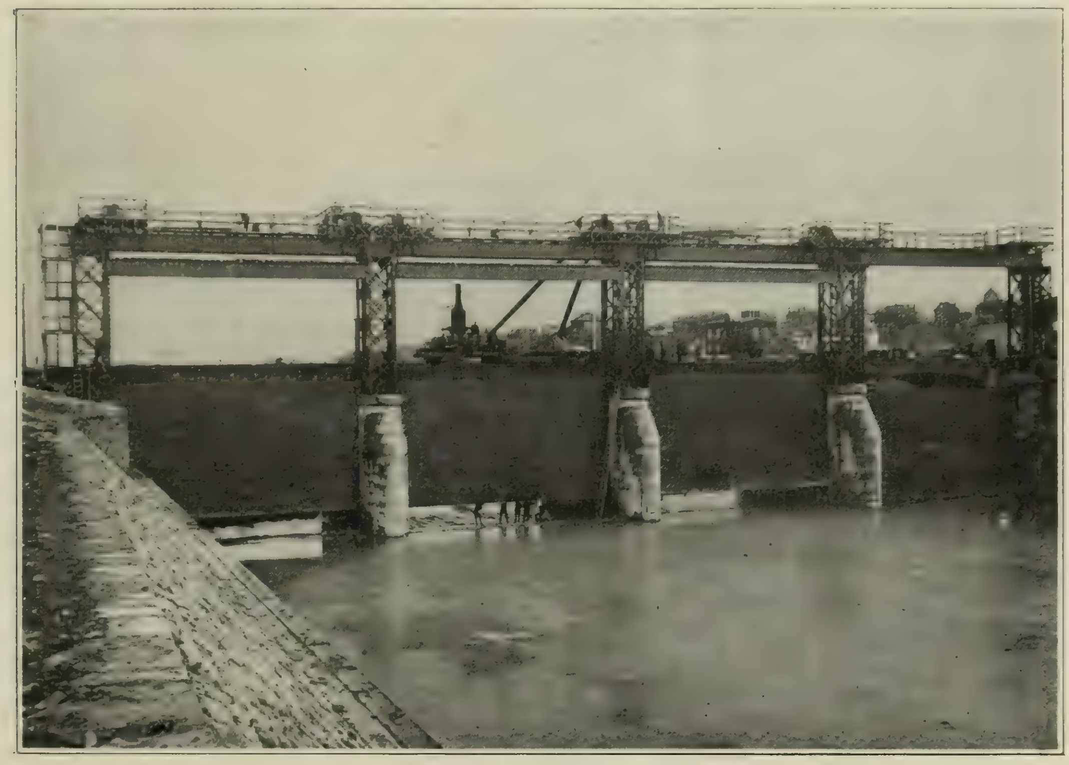


FIG. 4. UP-STREAM VIEW OF MOVABLE DAM OR HEAD GATE, SAULT POWER CANAL.

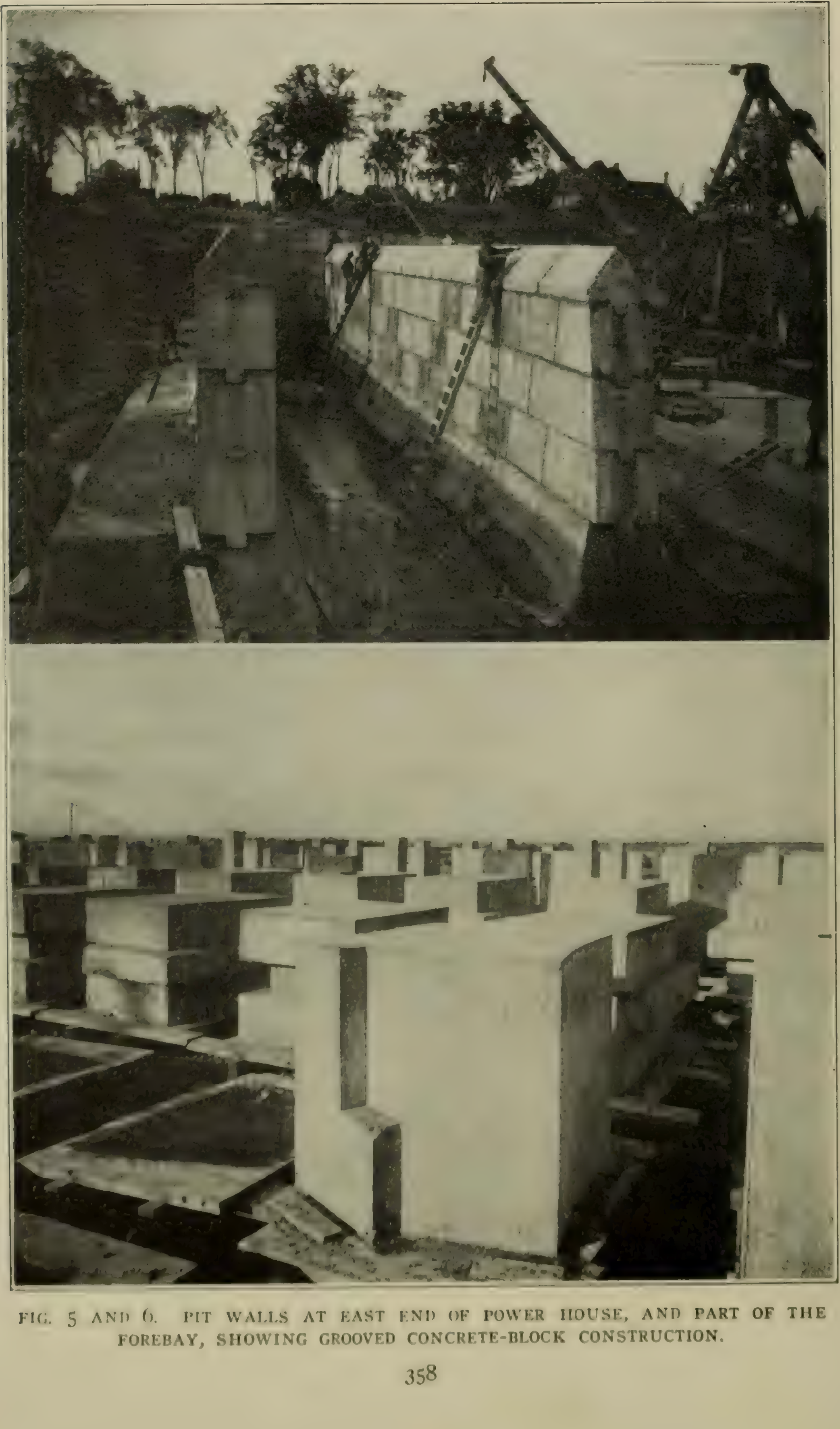


FIG. 5 AND 6. PIT WALLS AT EAST END OF POWER HOUSE, AND PART OF THE FOREBAY, SHOWING GROOVED CONCRETE-BLOCK CONSTRUCTION.

down-stream closing of the turbine chambers was of original design, being an arched steel bulkhead (see Figure 8) semi-circular, of 7½-feet radius, 28-feet high, built of ¼-inch mild-steel plates anchored to the concrete floor, which takes the place and performs the duty of the usual masonry gravity wall of heavy section. The building itself, of which an up-stream view is shown on page 361, is constructed of the sandstone excavated from the canal and contains, in addition to the 81 turbine chambers, some 2,360,000 square feet of floor space, or about 5½ acres.

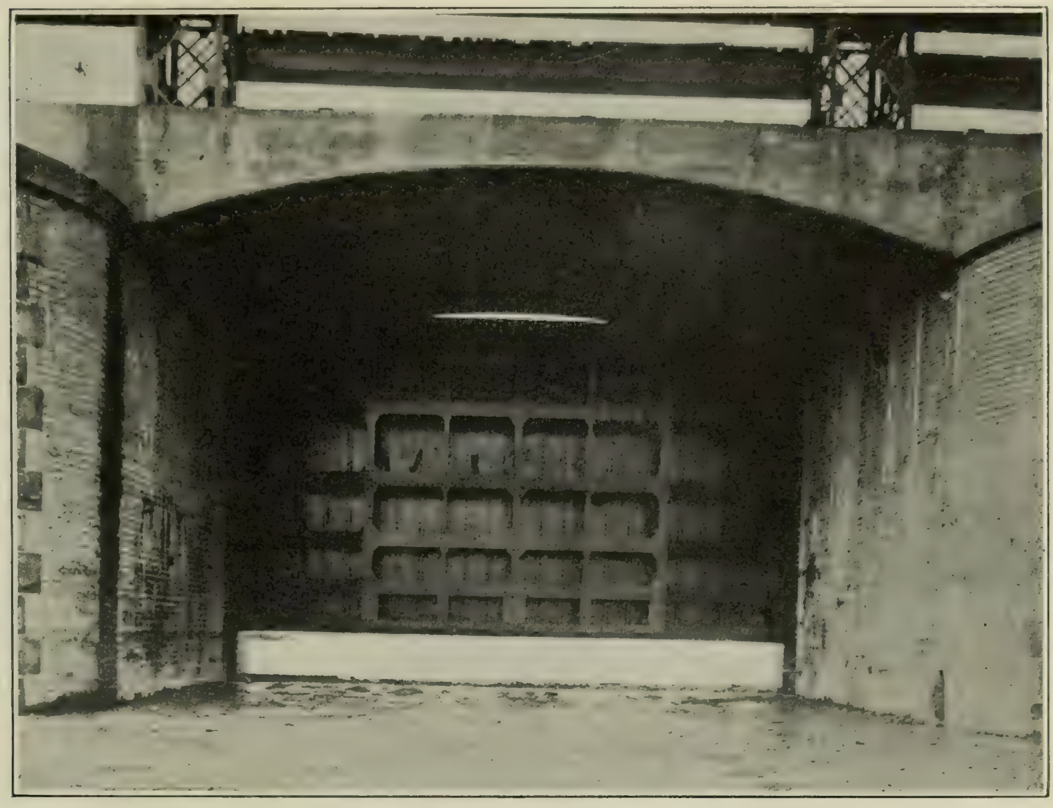


FIG. 7. DOWN-STREAM VIEW OF HEAD GATE, MICHIGAN-LAKE-SUPERIOR POWER COMPANY'S CANAL.

The entrance to the canal is guarded by gates of the Stoney sluice type shown above, while a similar structure stands at the head of the rapids, serving the purpose of reducing the natural outflow of Lake Superior and controlling the fluctuations.

The power-output units were fixed at 500 electrical horse power and a shaft speed of 180 revolutions, this being the requirement of one of the largest power customers and the best adapted for pulp grinding, for which the power was to be largely utilized. The capacity of the plant is 50,000 mechanical horse power. The equipment consists of 80 units of four 33-inch reaction turbines, placed horizontally on one shaft, which passes through the steel bulkheads and allows of coupling of generator or pulp-grinder shafts; Figure 12 shows some of these in place.

The cost of the total development was about $4,500,000. Commercially the enterprise has not yet attained the success which it deserves and will, no doubt, before long realize; 20,000 horse power are leased to the Union Carbide Company for the manufacture of calcium carbide; the east half of the power house is utilized for this purpose, electric power being generated by 375-kilowatt alternators, 60-cycle, single-phase, 200-volts; the current is carried by bus-bars to electric furnaces on the mill floor above; in these a mixture of coke and limestone is fused at a temperature of 4,000 degrees F., the product being calcium carbide, from which acetylene gas is generated. A street-railway system is being operated, and some lighting and motor current is furnished in the city. The early purpose was to utilize a large part of the output for grinding wood pulp from Canadian sources; this was defeated before completion of plant by an embargo placed upon export of Canadian pulp wood. The construction of a large paper mill designed to use some 3,000 horse power was interrupted in 1903 by the financial difficulties which overtook the company; a large tube-mill, which was to utilize some 8,000 horse power, was also contemplated and all the machinery was on hand at the

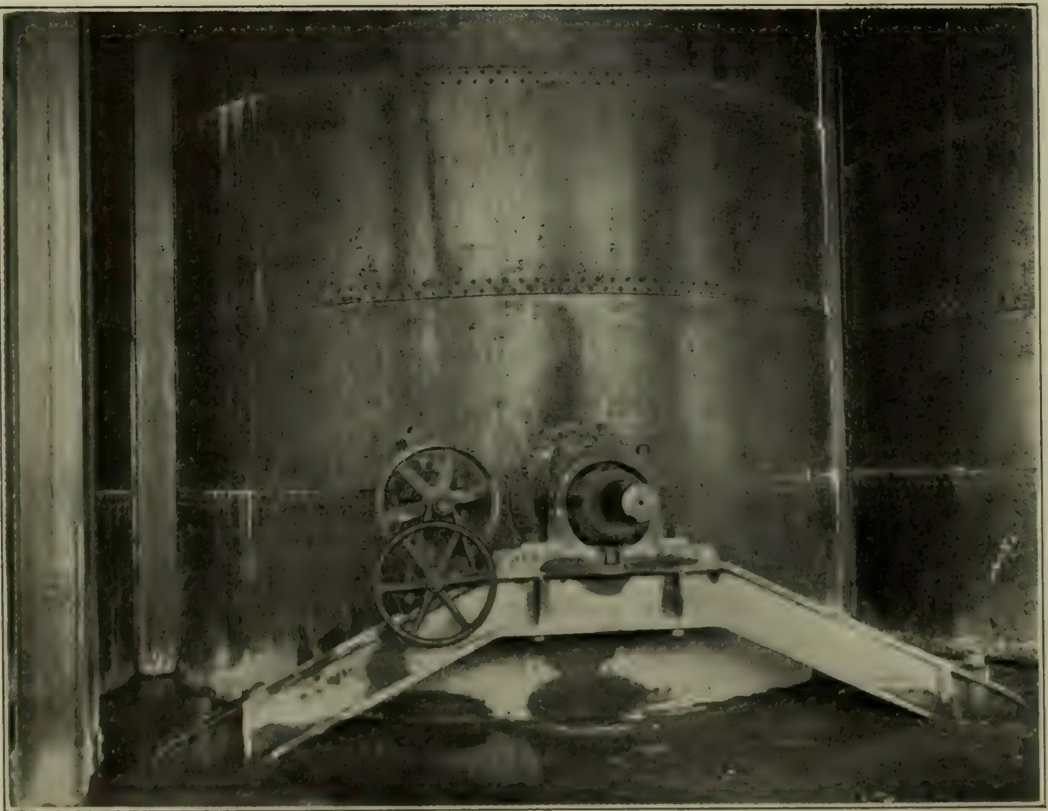


FIG. 8. ARCHED STEEL BULKHEAD CLOSING THE TURBINE CHAMBERS, SAULT ST. MARIE.

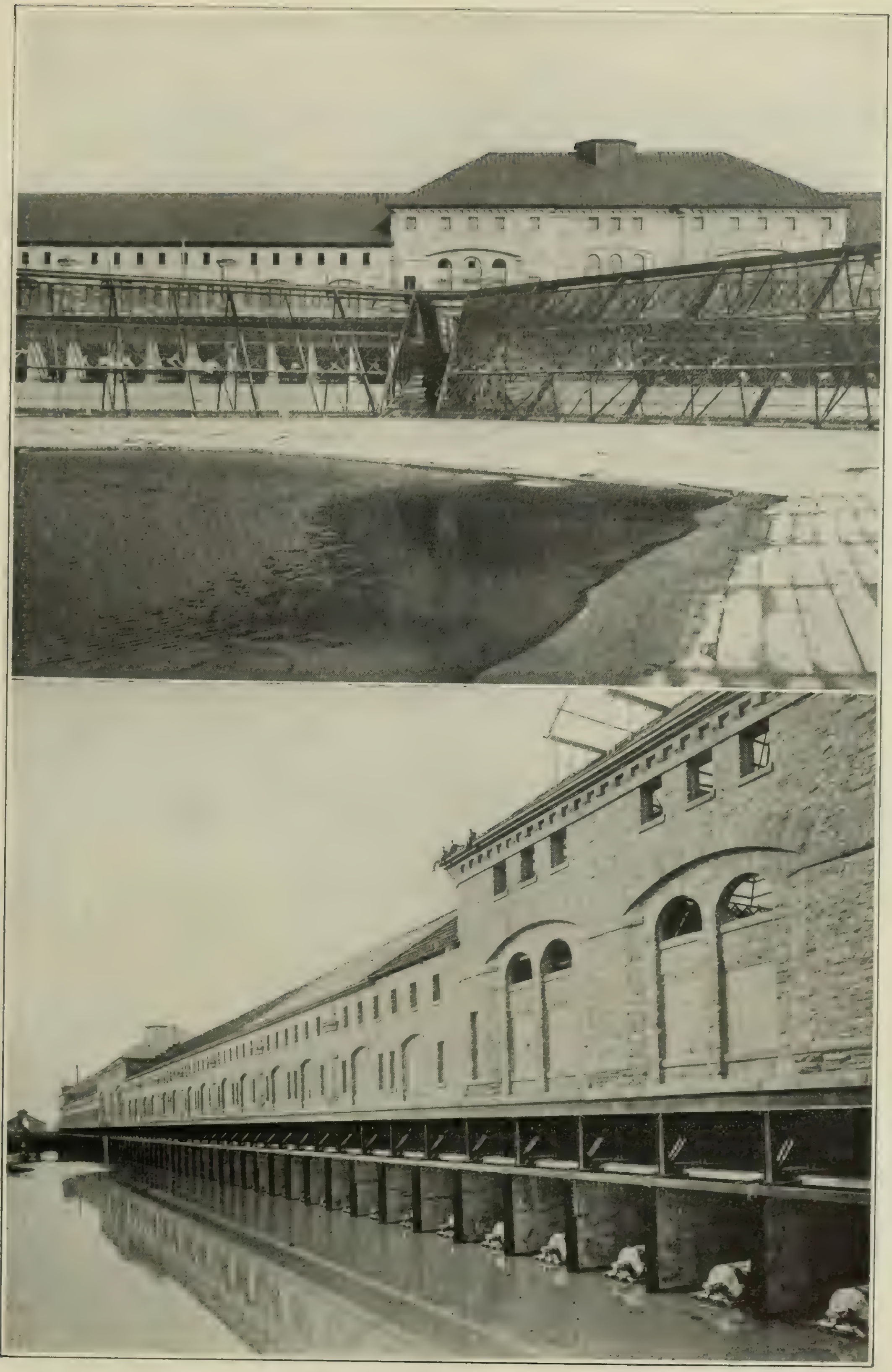


FIG. 9 AND 10. POWER HOUSE OF THE MICHIGAN-LAKE-SUPERIOR POWER COMPANY, SAULT ST. MARIE.

The lower view shows the general up-stream front; the upper shows the ice rack, from the bottom of the canal.

time of the financial crash; so was the machinery for a large paper-bag plant to be located in the power house—in fact, in another year or two all the power would have been disposed of. Nevertheless, the expectations of the originators will sooner or later be realized; the electric reduction of ores has now been practically developed at the Sault, and with the advantageous water transportation and proximity to the large copper deposits, this industry alone will before long use every horse power. The plant is designed and built for permanency and economy of operation and maintenance; the revenue from the present 20,000 horse-power contract will practically meet fixed charges and its ultimate commercial success can therefore not be stayed.

The hydro-electric development of the Georgian Bay Power Company, Ltd., of Toronto, Can., forms the second subject of description. This development is located in the Georgian Bay district of Ontario, its subject being the picturesque Eugenia Falls, which are situated on the Beaver river, emptying into Georgian Bay, Lake Huron. The contributing drainage area is 200 square miles, the available flow 80 cubic second feet, and the effective head 400 feet.

The development programme is of the distant diversion plan, the river being closed by a spillway and reservoir dam at the village of

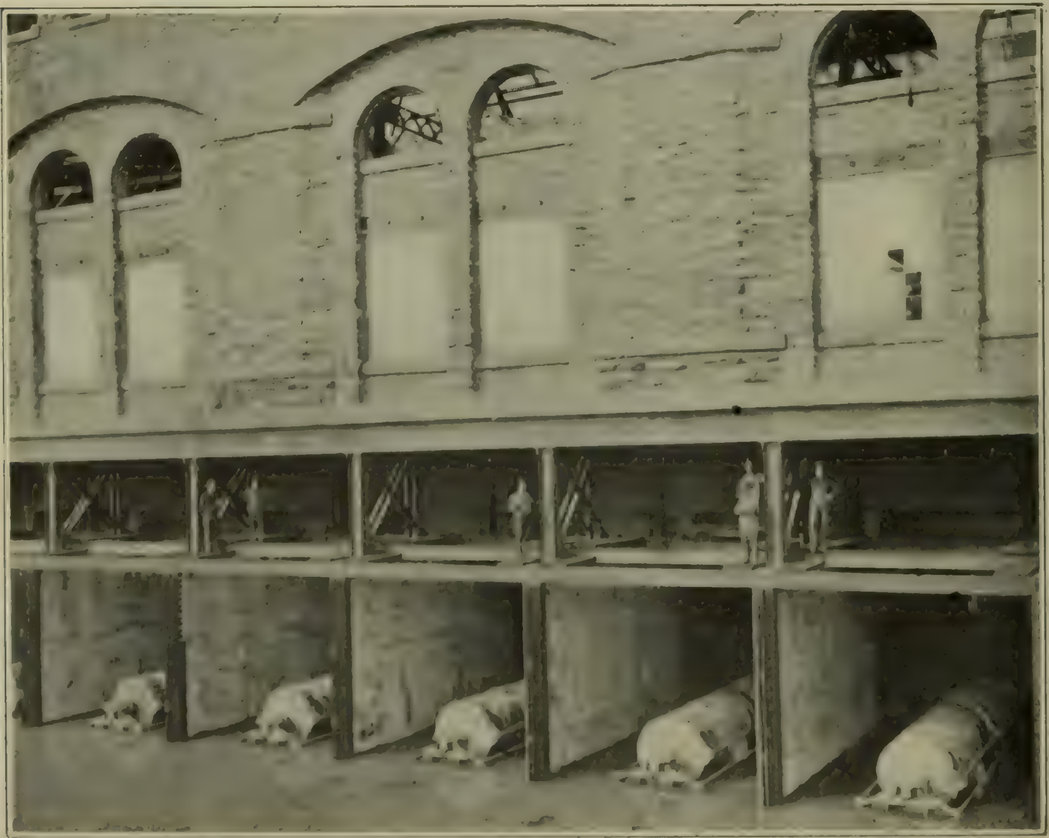


FIG. 11. ENDS OF THE PENSTOCKS, SAULT POWER PLANT.

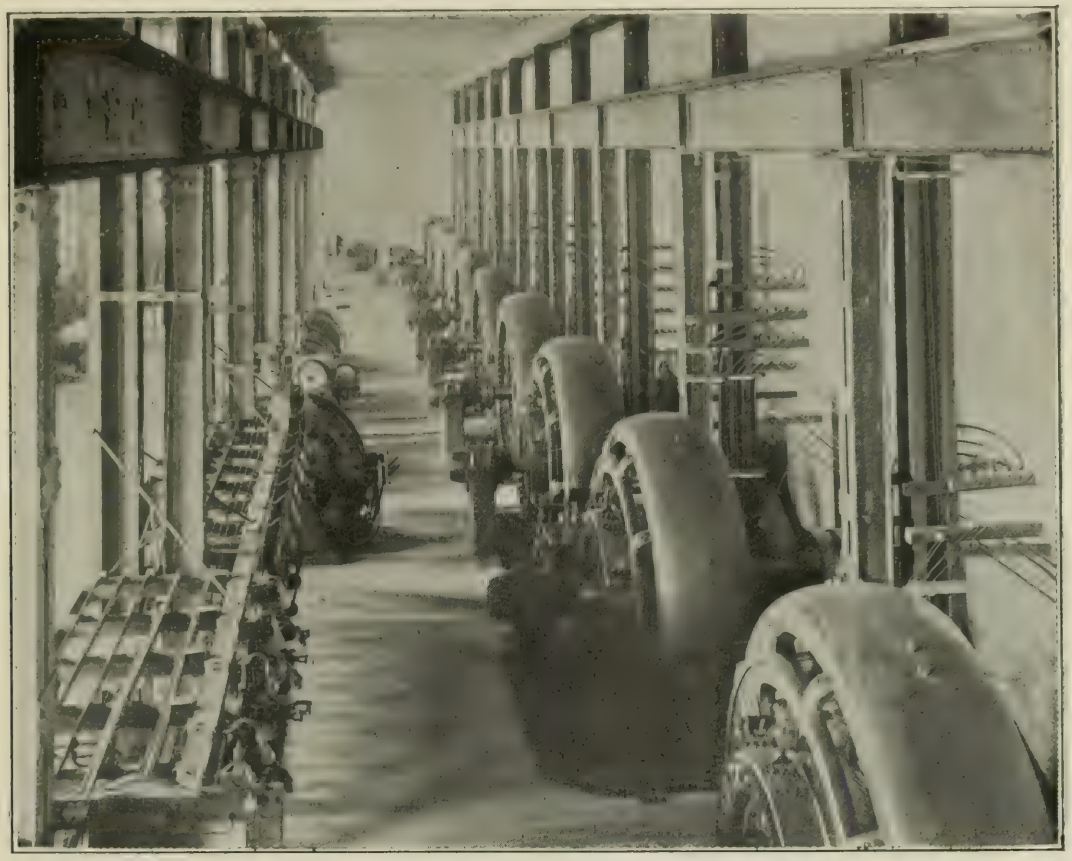


FIG. 12. INTERIOR OF SAULT POWER HOUSE. ELECTRIC-GENERATOR SIDE.

Eugenia, whence the water is conducted by a steel-pipe pressure line some 3,500-feet long to the power house on the river; the plan on page 364 outlines this programme. The distinctive features of this development are the dam, being of the Ambursen concrete-steel shell type, reservoir concrete-steel bulkheads, and the passage of the pressure line in part through a tunnel.

The spillway structure is representative of the latest development in dam designs. While the solid masonry or concrete dam (until recently considered the only safe and permanent device to impound flowing water) resists the pressures by its weight, this latter design utilizes the water pressure to maintain its position, through the adoption of a triangular form of such shape that the weight of water upon it equals the horizontal pressure component; this principle could be adapted to the solid type but would require such a large mass that its cost would be prohibitory, while this structure consists of a shell of concrete-steel in which the necessary strength and rigidity is secured by a very small fraction of the quantity of material needed in the solid structure. The advantages of such a type are manifold; its comparatively light weight requires less costly foundation and diminishes the danger of settlement and consequent cracks; the interior

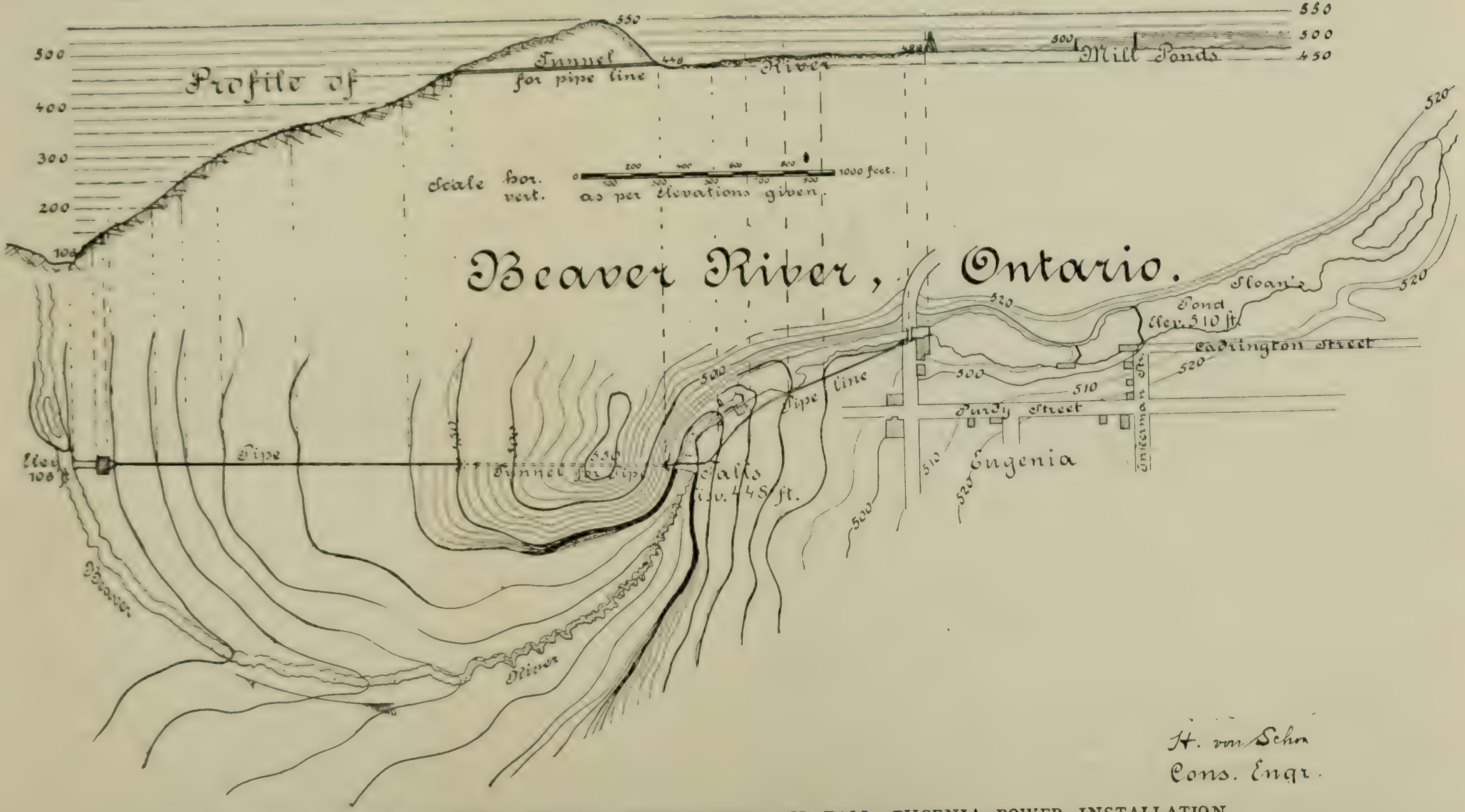


FIG. 13. MAP SHOWING GENERAL TOPOGRAPHY AND FALL, EUGENIA POWER INSTALLATION.

steel-bar net binds the whole into a homogeneous mass, imparting to it a greater resistance to the influence of fluctuating temperatures; danger from underwashing is minimized, since its stability, being independent of inherent weight, is not reduced by upward hydrostatic pressures, as is the case with solid dams; the flow during construction can be more readily and economically controlled, and the structure can be built in considerably less time than the solid dam; and, finally, the interior is accessible, can be inspected, repaired, utilized for arrangement of waste flumes and flashboards, and last, but not least, for the housing of the power equipment, as will be described more particularly in connection with the third plant to be discussed. The progressive construction of such a spillway is illustrated by accompanying views.

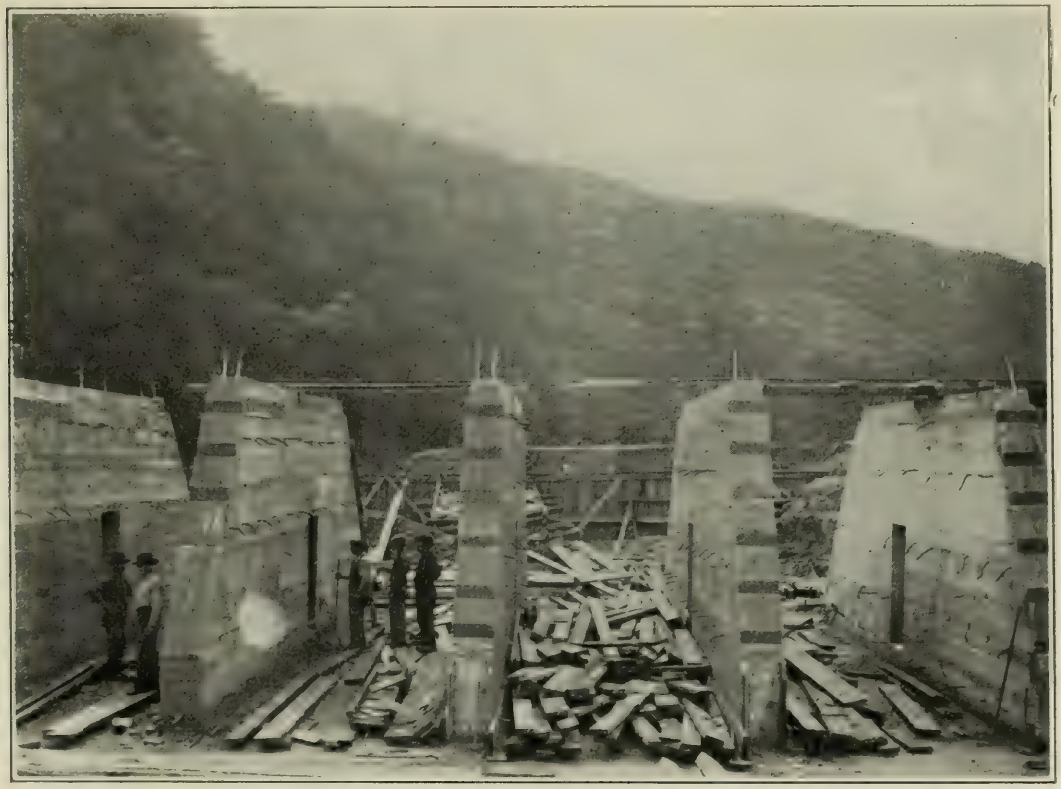


FIG. 14. SPILLWAY UNDER CONSTRUCTION ON THE JUNIATA RIVER.
Showing the reinforced-concrete buttresses. This is identical in type with the Eugenia installation. By courtesy of the Ambursen Hydraulic Construction Co.

The Eugenia spillway is 80 feet long and 40 feet high and consists of seven transverse concrete-steel partitions, or buttresses, of triangular shape, the up-stream ends on slope of one in one, the down stream one half in one; these are anchored to a rock ledge, 10 feet centers and 22, 18, and 12 inches thick from bottom up. The up-stream ends are covered by the concrete-steel deck, 24 inches at bot-

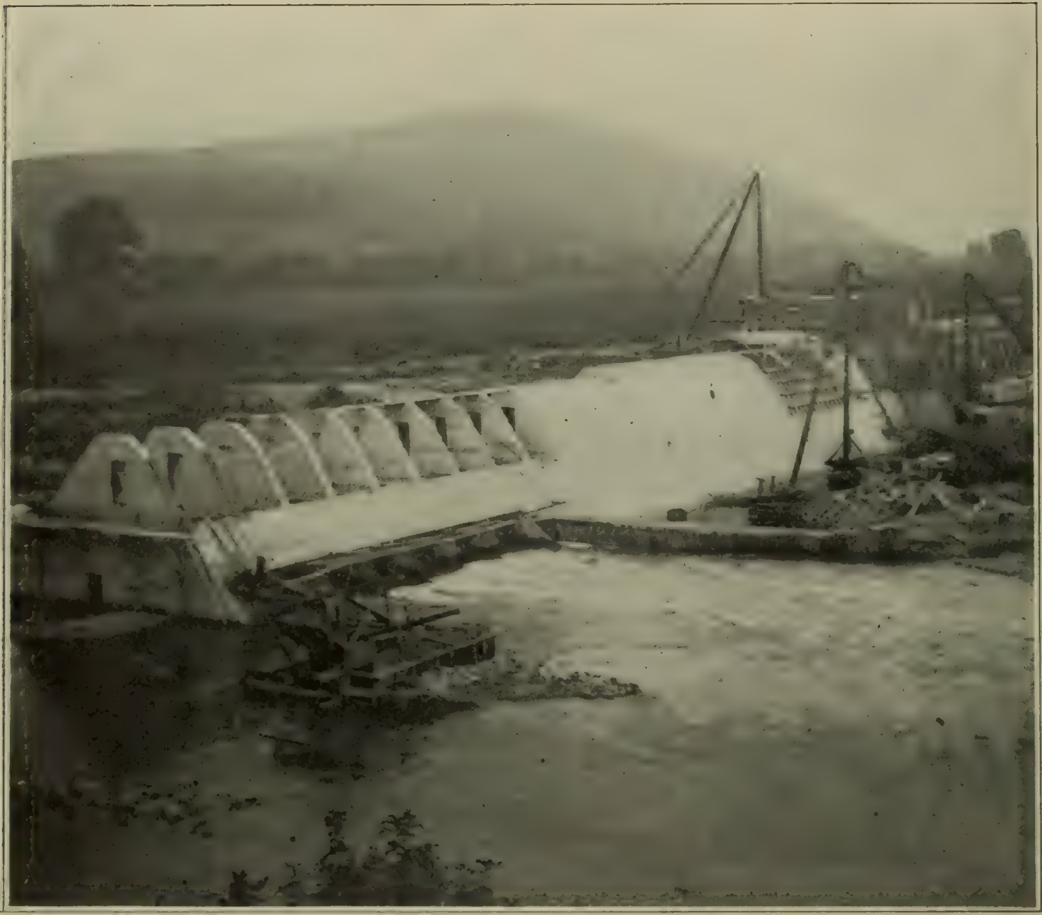


FIG. 15. THE JUNIATA SPILLWAY, PARTIALLY COMPLETED.

By courtesy of the Ambursen Hydraulic Construction Co.

tom, 12 at top, the down stream by the apron, the two being connected at top by the crown, 2 feet thick, 5 feet wide. Deck and apron are water-tight structures, their sections being sufficient to resist bending under water weight; openings are left in the buttresses, allowing of passage through the interior from end to end and preventing accumulation of lateral hydrostatic pressures against them; air vents are placed through the apron under the crown, creating free circulation, and thus avoiding formation of a vacuum beneath the overfalling sheet of water. The spillway is closed by concrete-steel buttresses, entrance to the interior being obtained through doors opening on the down-stream side. The complete closing of the river valley from bank to bank, some 1,000 feet in width, is accomplished by reservoir bulkheads, being of same design as the above described spillway minus the apron and rising six feet above the spillway crest, being safely above the highest probable pond level. These, as well as the spillway type, represent a departure from past reservoir structure practice, which had heretofore almost always adopted earth embankments with some kind of an interior core. The concrete-steel bulkheads are more economical in cost and absolutely permanent.

Water passes into a well on the south side of the spillway, to which is connected the 54-inch steel pipe conducting it to the power house three-quarters of a mile distant; on its way it crosses the river just above the falls and, curving northerly, pierces a bluff 150 feet high. The tunnel is 10 by 11 feet, lined with cedar which is obtained at the site; the pipe rests on timber frames. Emerging from the tunnel the pipe is reduced to 48 inches for 1,000 feet, passing down the hill side at a 10 per cent grade, and then to 36 inches, taking its final plunge down a steep incline. Concrete anchorages are distributed along the pipe-line location, and its terminal consists of a concrete bulkhead where it is separated into two 24-inch feeder pipes, each leading to a separate turbine in the power station.

The power house is of concrete and steel frame, 40 by 50 feet; the tail race is a concrete-steel flume.

The equipment consists of two Swiss wheels of the volute type; generators are coupled to the turbine shafts. The highly refined turbine installation presents many interesting features of controlling

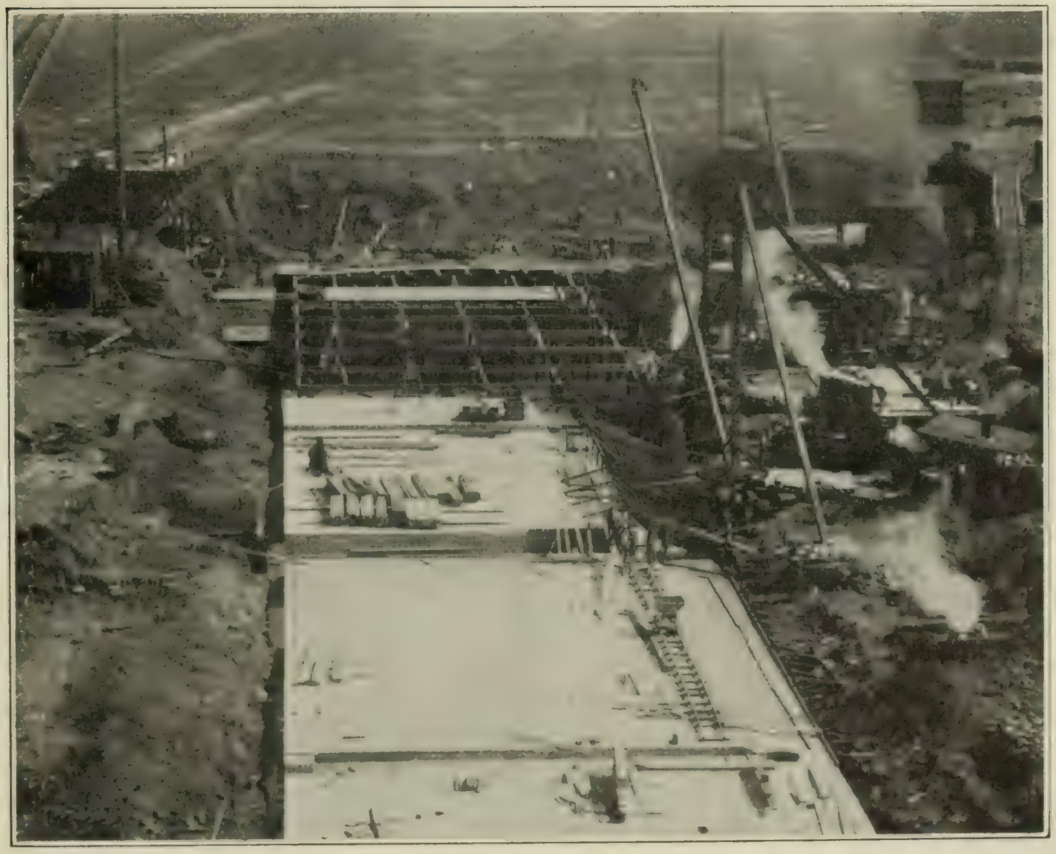


FIG. 16. FLOOR OF THE JUNIATA SPILLWAY, IDENTICAL IN TYPE WITH THE EUGENIA.
By courtesy of the Ambursen Hydraulic Construction Co.

the water and governing the output. The capacity of the plant is 2,500 electrical horse power, all of which is transmitted at a pressure of 13,000 volts on single-circuit three-phase line, to Owen Sound, Ont., 38 miles distant, where it is sold to cement plants, industrial shops, ship-yards, and for lighting, the rates being from $35.00 per horse power up.

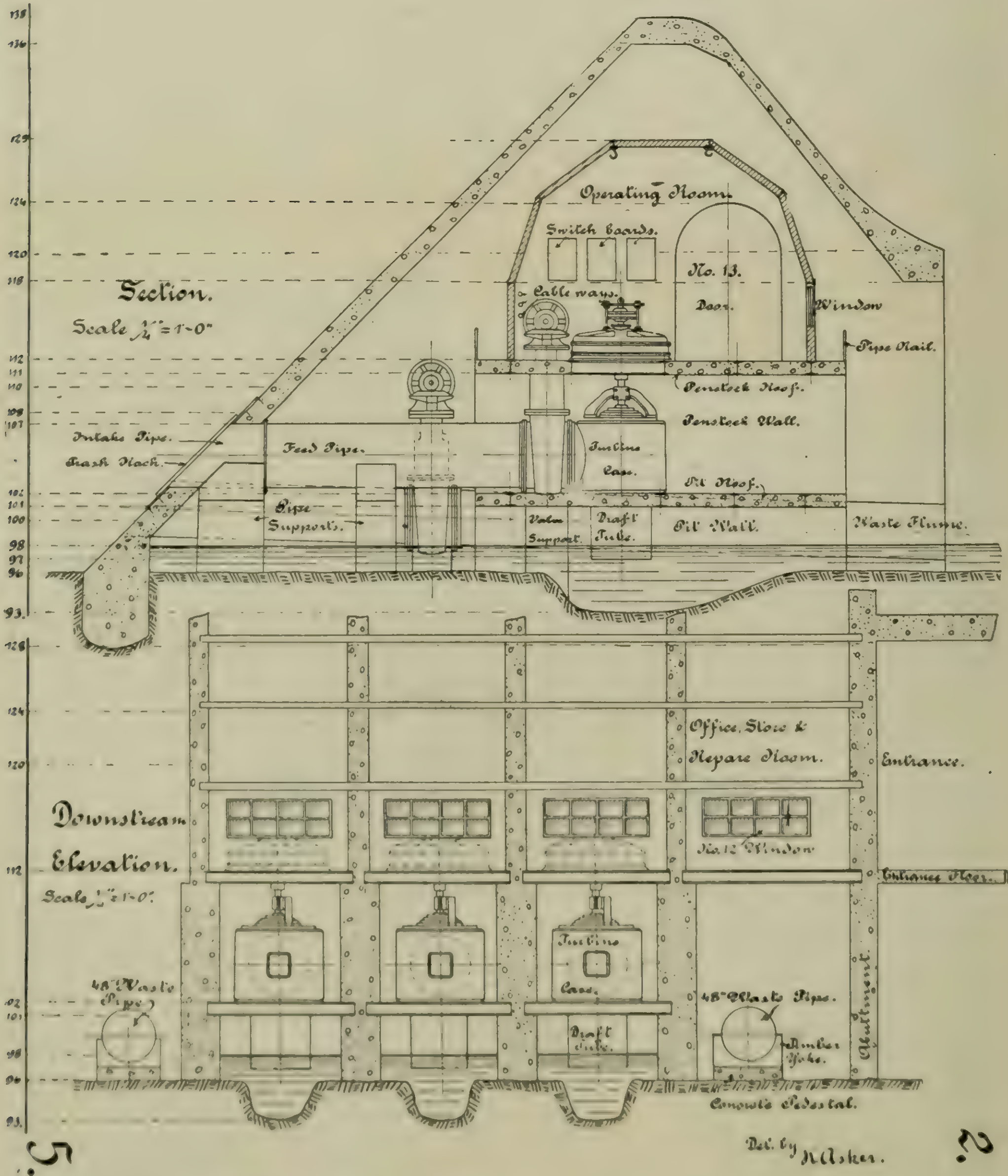


FIG. 17. CROSS SECTION AND ELEVATION OF THE PATAPSCO SPILLWAY, WITH INTERIOR POWER HOUSE.

The third subject to be described is the recently completed hydro-electric plant of the Patapsco Electric Mfg. Co., on the Patapsco River near Ilchester, some 16 miles from Baltimore, Md., on the B. & O. R. R. This is a re-development of a water power long ago harnessed,

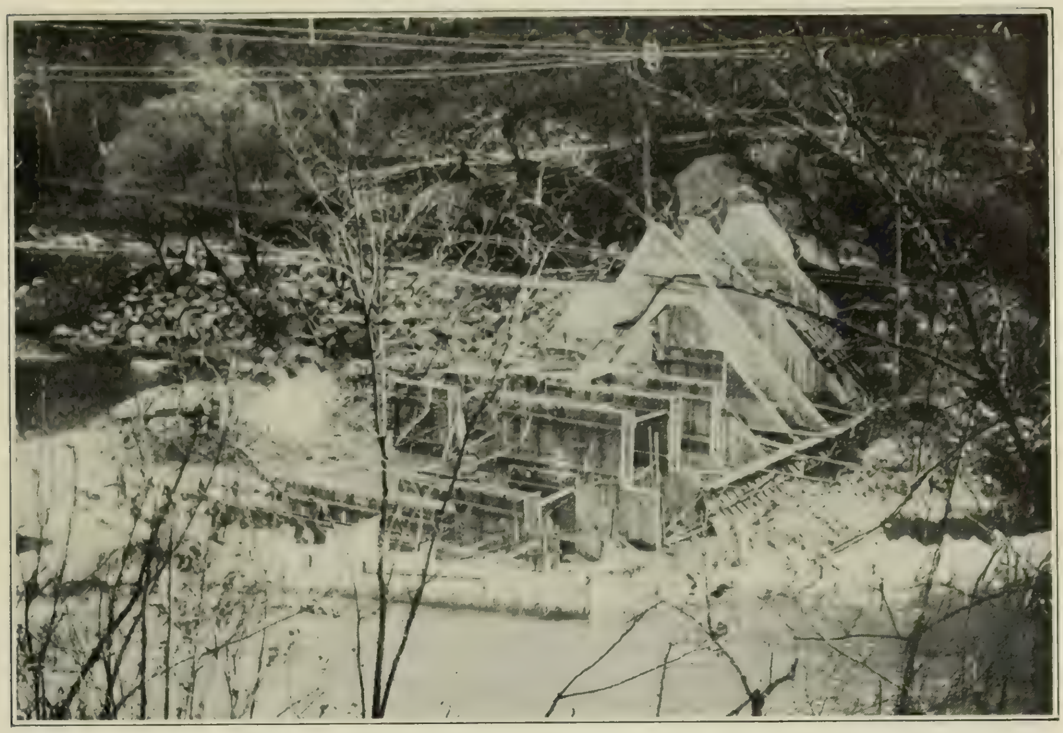


FIG. 18. A VIEW OF CONSTRUCTION WORK ON THE PATAPSCO SPILLWAY.

on a site formerly occupied by a timber dam; its peculiar feature of interest is the power station, which is placed in the interior of the spillway and is the first of this type yet constructed.

The spillway is of the concrete-steel shell type just described, 245 feet long and 38 feet wide; the apron extends only half way down from crown, the remaining down-stream portion being entirely open. It is founded on a rock ledge and closes the entire river valley. With the foregoing description of the hollow dam the arrangement of the interior power station will be readily understood. The hollow spillway is divided by buttresses into chambers which are utilized for the placing of equipment. For this purpose a concrete-steel floor is placed at a proper elevation above the lower pool, between buttresses, the latter being increased in section below this floor; a housing of hollow-tile walls and roof is placed upon the floor, leaving an air space between it and the spillway shell. The turbines, in cases, are placed on this floor; their installation may be on horizontal or vertical shaft, in accordance with the height of chamber available; water is brought to the turbines by means of steel feed pipes passing through the up-stream spillway shell, and discharged by draft tubes into the base of the dam, dropping into a well sunk some three feet below the river bed; it passes thence by way of a channel constructed in the river bed, out of the dam. The flow through the feed pipe is controlled by a valve-gate operated from the turbine chamber; a trash-

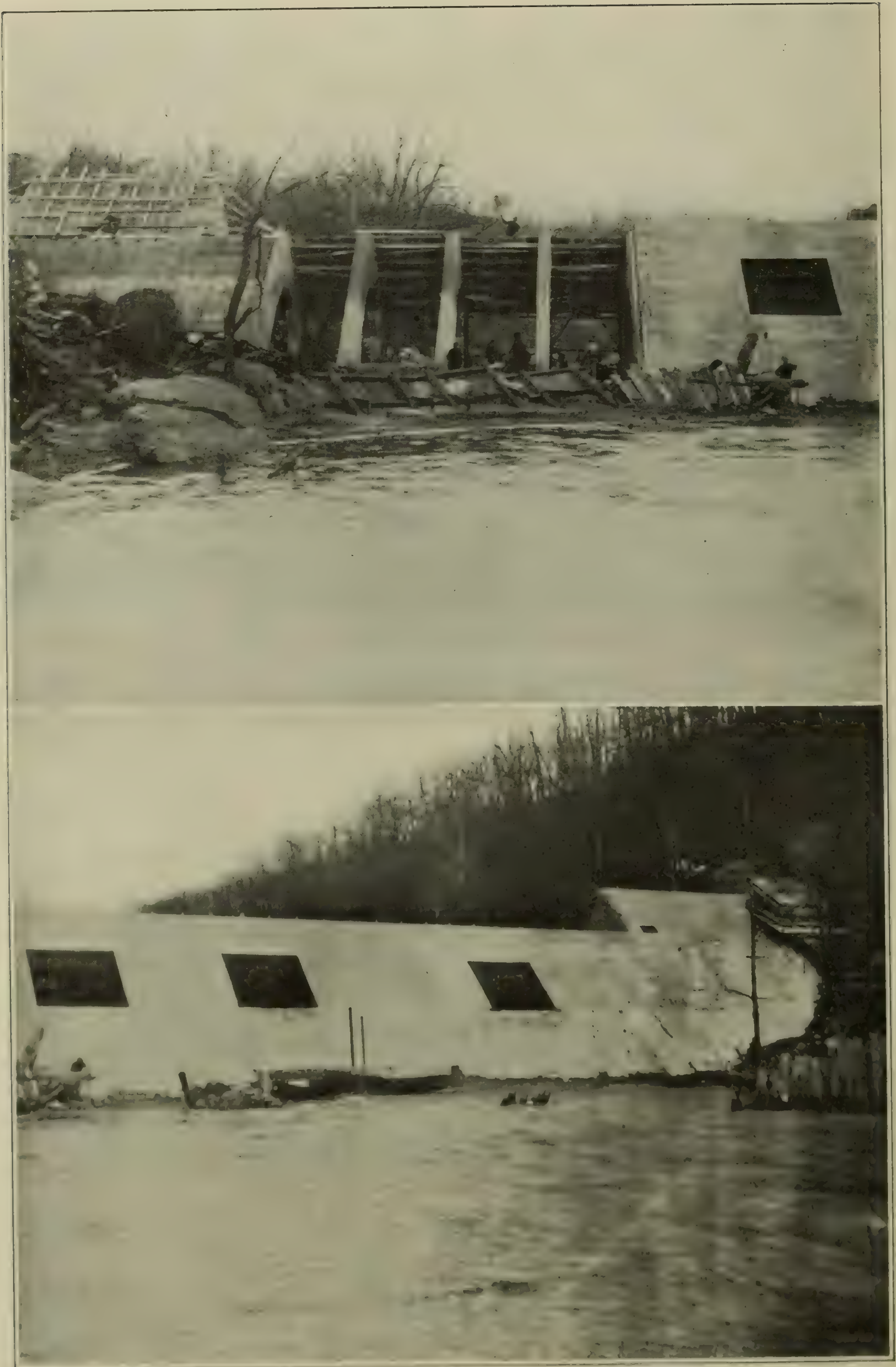


FIG. 19 AND 20. SPILLWAY OF THE PATAPSCO HYDRO-ELECTRIC POWER INSTALLATION.

The upper view shows the hollow form of the spillway. The lower illustrates the completed structure, with the openings for windows lighting the interior power station.

rack is placed in front of the intake to the feed pipe. The advantages of such an arrangement are readily discerned; the dam foundation and structure are the power house; the chamber is absolutely free from moisture, by reason of free circulation of air around it; the development utilizes all the available fall, and during periods when water passes over the spillway crest its suction force as it passes the mouth of the tail race lowers the water level in the tail-race well and thus increases the effective head, which would be reduced were the power house located below the dam.

The chamber receives light through windows on the down-stream side, air through ventilators, and there is ample room to move, install, and repair any part of the equipment. The generators are coupled to the turbine shaft. The installation is compact, secure, and of highest practicable efficiency as far as it can be obtained from flow and fall. The cost of the power station is, of course, very much less than that of any other arrangement.

The sections and views here given illustrate the structure, which is practicable wherever the spillway is 30 feet high, or higher. This station contains three power units, with output of 1,650 horse power, all of which is used by the Patapsco Electric Mfg. Co., but it would accommodate as many units as there are spillway chambers. The plant was constructed by the Ambursen Hydraulic Construction Company, of Boston, Mass.; the design was developed and patented by me.

I have collected data of undeveloped water powers in America for several years and their number is surprising. Generally speaking, they may be divided into three classes—the powers which are entirely unimproved as yet and controlled by private interests, those of the waste flow passing over the dams at Government locks, and those depending upon the re-organization and modernizing of the old mill powers, many of which are now idle, none of them having been originally developed to their available capacity.

Space will permit quotation of a few, only, and a selection has therefore been made, chiefly from those which I have personally examined, and of which I am in a position to present the essential facts. The flow referred to in these descriptions is the available power flow, or the low flow replenished from obtainable storage to meet the normal conditions; the fall is the effective working head; output capacity is given in electrical horse power at the generator switchboard, and cost represents the works and generating equipment. The names and addresses of parties controlling the opportunities are given to enable possible investigators to direct their inquiries to the proper people. The list appears on the following pages:

ALABAMA.

1. Black Warrior River. At Locust Fork a succession of several falls can be developed with available storage. Mr. E. J. McCrossen, of Birmingham, Ala., controls the sites together with large acreage of what is represented to be valuable timber land. Mr. McCrossen states that 325 feet fall can be had and 2,500 horse power developed economically at a point about 25 miles from Birmingham, Ala. I have not seen an engineer's report on this project.

2. Tallapoosa River. What is known as the Cherokee power site is controlled by the Cherokee Development and Manufacturing Company, of Birmingham, Ala. This opportunity has been exploited by engineers' reports for some time; the power site is at a rock gorge, 150 feet wide, with river expanding above and below to more than 1,000 feet; ample storage appears to be feasible. A fall of 100 feet is said to be available and, in a report made by Mr. Henry C. Jones, of Birmingham, Ala., a continuous output of 18,000 horse power for 10-hour service is claimed as potential with additional power available during all but low season. An estimate of development and delivery to Birmingham, Ala., 100 miles, is presented in that report, aggregating $2,500,000.

3. Coosa River. Near the crossing of the Seaboard Railroad in St. Claire and Calhoun counties is a proposition which has been promoted for some time by the Coosa River Electric Power Co., of Birmingham, Ala., Mr. Roswell H. Cobb, president; it has been surveyed and reported on by Robt. R. Zell, of Birmingham. This development is planned, under Congressional act passed last year, at Government Locks Nos. 2, 3 and 4, by construction of a new dam and raising of levels whereby a fall of 36 feet is said to become available, and a power output of probably 12,000 horse power. I have not seen a detailed cost estimate; it is likely to reach $100 per horse power. Gadsden, Ala., is 15 miles, and Anniston, Ala., 14 miles from the site, and these points are alleged to offer good markets.

4. Big Wells River. In Etowah county, about 1½ miles from Attalla, Ala., it is reported by the Etowah Light & Power Co., Mr. A. Brown, Mgr., of Etowah, Ala., a fall of 17 feet can be secured and a development of about 1,000 horse power. The dam location is in rock; the power house would be at the end of the dam. The current is to be used by the company in their plant in Etowah, now run by steam.

5. Little River. A power site in Cherokee County (the nearest town being Menlo, Ga., 9 miles distant) is described by Mr. H. J. Lawrence, of Menlo, Ga., as being capable of developing 10,000 horse power by erecting a dam 55 feet high and 1,500 feet long, and by 1½ mile diversion of flow, securing a fall of 550 feet. The river at the dam site is reported to be in sandstone. I have not seen an engineer's report on this development, but it appears to possess the elements of an economical opportunity. Gadsden, Ala., is 30 miles and Rome, Ga., a like distance; these are both good market points.

6. Tallapoosa River. Another power on this stream is in Tallapoosa County, about 6 miles from Alexander City, Ala., about ½ mile from the main line of the Central R. R. of Ga. Mr. R. A. Chapman, of Montgomery, Ala., now at the U. S. Engineer's Office in that city, has surveyed and reported on this power and states that a dam 85 feet high and 500 feet long

can be placed in a granite rock location, creating 80 feet of working head and an output of 6,000 horse power. Montgomery is 47 miles, Birmingham 60 miles from the site.

7. Pea River. The Pea River Power Co., of Elba, Ala., Mr. H. D. Boyd, secretary, advise that they control several power sites which can be economically developed and the output marketed at Elba and Troy, Ala. I have no details of fall, development programme, or cost.

ARKANSAS.

8. Kings River. In Carroll County, 1½ miles from the town of Grand View, the Kings River Electric Power Co. control a site reported by them to permit of placing in rock location a dam 22 feet high and 325 feet long, thereby creating a fall of 21 feet and securing an output of 1,000 horse power. The dam can be built for $30,000 and $70 per horse power will probably cover the development cost. I have not seen an engineer's report on this project. The market will be at Eureka Springs and Berryville, Ark., 10 miles distant.

9. Little Missouri River. The Southern Power & Development Co., of Ozark, Ark., Mr. D. A. Allen, president, have a site in Montgomery, Ark., where a 65-foot high dam 235 feet long can be placed in a rock gorge. The company state that they can develop 1,000 horse power, but have not submitted any engineer's report. Market for current would be at Black Springs, 25 miles, and other points.

COLORADO.

10. Taylor River. Mr. Albert B. Sandford, 1727 Champa Street, Denver, Colo., controls the rights for the use of the waters of this stream, one of the largest tributaries of the Gunnison River, in Gunnison County, Colo. Rights for storage in Taylor Park, Mr. Sandford states, have been secured aggregating capacity of 4,000,000,000 cubic feet. The fall in the river aggregates 100 feet per mile for a distance of 12 miles, and all of this can be made available by erection of dam at the head of Taylor River Cañon, which is a gorge of vertical quartzite and limestone walls about 100 feet wide at river bed; the dam could be raised to a height of 125 feet. The power output and its cost have not been reported on, but this is one of the largest hydro-electric propositions of that section, probably representing 40,000 horse power, and the cost should be economical. The site is 40 miles from Leadville, 85 from Cripple Creek and Colorado Springs, and 125 miles from Denver.

11. Cache la Poudre. In Larimer County, 8 miles from Fort Collins, 90 feet fall can be utilized (without dam construction) from Poudre Valley Ditch, controlled by the Poudre Valley Res. Co., Mr. O. J. Blandin, president, at Eaton, Colo. Mr. Blandin advises that 900 horse power can be developed in a very economical way and market profitably at Fort Collins, Colo.

GEORGIA.

12. Etowah River. I am advised by Mr. R. L. West, superintendent, Southern Tel. & Tel. Co., Atlanta, Ga., that he controls a power site in Barton County, 14 miles from Rome, Ga., where a 30-foot dam 600 feet long can be placed in rock location and create 32 feet fall, giving an output of 3,000 horse power, all of which could be sold at Rome. This appears to be a promising opportunity, but I have not seen engineer's report covering it.

13. Broad River. The Anthony Shoals Power Co., Mr. J. H. Fitzpatrick, president, Augusta, Ga., control a site on Broad River in Wilkes and Elbert Counties, 17 miles from Elberton, Ga. This project has received considerable investigation by engineers. Anthony Shoals, Broad River, are about a mile long and represent a fall of 55 feet, the river being 800 feet wide; the last development programme I have heard of contemplates a 70-foot high dam 1,450 feet long, giving a head of 85 feet. The location is alluvial in part; the Broad River is subject to flood rises of some magnitude. This last proposition is to develop 13,000 horse power, the current being transmitted to Augusta, Ga., 50 miles.

14. Ocmulgee River. At the Lamar shoals, about 4 miles from Flovilla, Ga., and 3 miles from the main line of the Southern Ry. I am advised by Mr. Walter D. Lamar, of Macon, Ga., who controls this site, that a 20-foot high dam will secure 45 feet of fall, the water being diverted ¼ mile. The flow is about 1,000 second feet, and under these conditions some 3,500 horse power could be developed. I have not seen an engineer's report nor any estimate of development cost. The current can all be sold in Macon, Ga.

15. Amicalola River. On this tributary of the Etowah River, at a point known as Heard's Shoals, is a promising power site controlled by Mr. S. D. Pickett, president, Albany Power & Mfg. Co., of Atlanta, Ga. Heard's Shoals are in Dawson County, Ga., within 8 miles of the great Georgia marble quarries in Pickens County. The site is within a few miles of the main line of the A. K. & M. R. R. This project has been reported on; according to the report a 50-foot high dam 200 feet long can be placed in rock location, and by 2-mile diversion a fall of 205 feet can be secured and 5,000 10-hour horse power developed. The cost is not given, but will probably be $100 per horse power. It is 22 miles from Gainesville, Ga., 45 from Atlanta.

IDAHO.

16. Elk Creek. In Nez Perces County, Mr. B. E. Bush, of Moscow, Ida., controls a 300-foot fall power site which can be developed, without dam construction, by diversion of flow from basalt-rock creek bed in a flume or pipe line. Mr. Bush advises that 2,000 horse power can be developed very economically, and that the product can be marketed at Moscow, 40 miles from the site. This is in the center of the new wheat belt and in the North Idaho white-pine region. I am advised that a railroad is being constructed from Palouse City to this site.

17. Snake River. The Shoshone Falls site in Cassia County is 4 miles from the town of Twin Falls. This is one of the several important undeveloped powers of the Snake River, representing a fall of 130 feet and allowing of a development exceeding 20,000 horse power. The dam, if any is needed, will be only a few feet high, the diversion short, and the cost of development therefore low. However, the only available market for such an output is at Salt Lake City, 200 miles, and the transmission problem and cost is the feature. The site is controlled by the Shoshone Power Co., Mr. Francis M. Lyman, president, Salt Lake City, Utah.

ILLINOIS.

18. Rock River. At Grand Detour, Ill., the river makes a large bend; the flow can be diverted across the ½-mile-wide peninsula and a fall of 15 feet can

be secured with a 12-foot high dam. The available flow here is 1,250 second feet, the power output 1,500 horse power. This site is owned by Mr. S. B. Newbury, of the Sandusky Portland Cement Co., Sandusky, Ohio, who acquired it originally for the purpose of furnishing electric power to a cement plant now nearing completion at Grand Detour, but this plan, I understand, is not now to be carried out. The current can be sold in Dixon, Ill., 6 miles, and at Sterling, Ill., 18 miles distant. A report has been made on this project by Mr. L. L. Wheeler, U. S. assistant engineer, stationed at Sterling, Ill.

19. Rock River. Another site is found some 50 miles below the one above mentioned, near Lyndon, Ill., the flow here being about 2,000 second feet, with an available dam site giving 10 feet fall; it is controlled by the Morrison Gas & Electric Co., Mr. Harvey S. Green, proprietor, Morrison, Ill., which latter point, 15 miles from the power site, is the market for the current. Both these Rock River projects are authorized by Congressional act, the river being navigable and under control of the War Department.

INDIANA.

20. Blue River. In Harrison County, 9 miles from Croydon, Ind., is a power site of 20-foot fall and an output of 1,000 horse power. It is controlled by Mr. Wm. Rothrock, of White Cloud Mills, at White Cloud, Ind. Surveys have been made but report and estimate have not been submitted.

INDIAN TERRITORY.

21. Grand River. At Flower Creek, near Fort Gibson, I. T., a dam 45 feet high and 450 feet long will create a head of 30 feet and a development of 7,500 horse power at a cost of about $75 per horse power. The current would be transmitted to Muskogee, I. T., now of 25,000 inhabitants, where it can all be sold at good rates. A contract can be made with the city for water supply from this dam, the present service being taken from the Arkansas River (the Grand empties into the Arkansas near Muskogee) which is very unsatisfactory on account of the constantly turbid condition of the water. Muskogee is 12 miles from the power site; the Frisco R. R. line passes the proposed dam location. This project is one of the most promising in that section of country, and with some storage provisions can be enlarged. Muskogee is growing very rapidly; five trunk railroads now center there and others are projected, while provisions have been made in the last River and Harbor Act to improve the Arkansas navigation channed from Fort Smith, 80 miles below, to Muskogee. Mr. C. N. Haskell, president of the Indianola Construction Co., Muskogee, I. T., controls this project. Report has been made by the author.

22. Grand River. At Carrie Island, some 26 miles from Muskogee, is a second power site where the river is divided into two channels by an island, and a fall of 40 feet can be obtained yielding an output of 10,000 horse power. This output could be taken to Fort Smith, Ark., 75 miles, and find profitable market. Mr. C. N. Haskell, of Muskogee, I. T., also controls this site, which was reported on by the author.

23. Blue River. Near Belton a succession of falls and rapids can be utilized by economical dam construction in rock location so as to give a head of 40 feet and an output of about 1,000 horse power at a cost of $80, which can be marketed at Tishomingo, I. T., 10 miles. Mr. W. C. Wells, of Tisho-

mingo, I. T., engaged the author to report on this project two years ago; it is yet undeveloped.

24. Pennington River. Near Tishomingo, I. T., a fall of 123 feet can be obtained by constructing a dam 8 feet high and 100 feet long, on rock, and diverting the flow in flume and pipe line 3½ miles, developing 1,000 horse power at a cost of $100 delivered to Tishomingo, I. T., 3 miles from the power house. Tishomingo is one of the growing cities of the Territory, the capital of the Chickasaws, has large marble quarries and is in the cotton belt, with two railroads. The power is controlled by Mr. C. B. Burrows, president, American National Bank of that city. The author has prepared plans and rendered report on the project.

25. Illinois River. Near Tahlequah, I. T., is a power site controlled by the Illinois River Light & Power Co., Mr. Fr. R. Lewis, president, Tahlequah, I. T., where a fall of 30 feet can be secured by a dam 34 feet high and 175 feet long, on rock bed, the power station to be arranged in the interior of the dam. The output here will be 1,500 horse power at a cost of $75, and all the current can be marketed at Tahlequah, 6 miles distant. This town, like Tishomingo, is rapidly growing; it is in the cotton belt and a region of large hardwood timber tracts. The author has rendered report on the project.

IOWA.

26. Cedar River. Not far from the mouth of this river there is an opportunity to gain a fall of 90 feet by diversion across a peninsula, by tunnel and open canal, of the Cedar River flow into the Mississippi; this would yield a development of some 10,000 horse power, the market for which would be at Muskatine, Ia., 8 miles, Davenport, Ia., 25 miles. Mr. E. B. Downer, of Muskatine, Ia., controls this project and has supplied these data.

MICHIGAN.

27. Manistee River. The flow is 1,500 cubic second feet, this river being noted for constancy on account of drainage-area conditions guaranteeing a very high ground-storage capacity; it is not subject to floods. The river bed is alluvial; there are two sites, of 45 and 68-feet fall; an output capacity of 14,000 horse power can be developed at a cost of about $50 per horse power. The market for the current is at Grand Rapids, 100 miles; Muskegon, 75; Ludington, 30; Manistee, 22; Traverse City, 25; Cadillac, 15 miles, and other points. The property is owned by Mr. J. N. Salling, Manistee, Mich. Reported on by H. von Schon.

28. Au Sable River. The flow is 1,200 cubic second feet, the drainage-area characteristics being similar to those of the Manistee, both streams rising on the ridge in the center of the lower peninsula of Michigan; the formation is of deep drift with large ground storage and several lakes; the river has no flood rise. Several dam sites are available with 20 to 38 feet fall; the capacity of those from Flatrock down is about 13,000 horse power. The development will cost $65 per horse power. Market is at Au Sable and Osceola, 20 miles, and Bay City and Saginaw, 60 miles. The property is owned by H. M. Loud Sons Co., of Au Sable, Mich. Report has been made by H. von Schon.

29. Thunder Bay River. Flow is about 600 cubic second feet and subject to normal fluctuation. In the lower reach rock comes to surface and ground

storage is not as good as on Manistee and Au Sable, but there are several reservoir opportunities. Two power sites have been improved, but several others remain available—one of 40 and two of 25 and 30-feet fall respectively. The first is in rock location, the others in alluvial, chiefly of gravel and clay. Output capacity of these three is about 4,000 horse power, which can be developed at a cost of about $60 per horse power. The market is in Alpena, 20 miles. The property is controlled by the Fletcher Paper Co., of Alpena, Mich. H. von Schon has made surveys.

30. MONTREAL RIVER, Upper Peninsula. Available flow, utilizing three reservoir sites, is about 100 second feet, and a fall of 110 feet can be concentrated at a point ½ mile below the falls by diverting the flow in a pressure line. The output is reported to be 1,000 horse power at a cost of $110 per horse power. Market is at Ironwood and Bessemer, 10 and 18 miles. Property is controlled by Mr. E. D. Nelson, president, First National Bank, Ironwood, Mich., who also owns the Ironwood light, water and street railway plants and the electric line from Ironwood to Bessemer. The project has been reported on by Mr. F. A. Cokefair, C. E., of Duluth, Minn.

31. MENOMINEE RIVER. At the Grand Rapids, with a drainage area of 3,800 square miles, flow of 2,000 second feet, and fall of 27 feet. The power development includes a short diversion canal and will realize about 5,000 horse power at a cost of $60, which can be marketed at Menominee, Mich., and Marinette, Wis., 15 miles. Mr. Wm. Holmes, of Menominee, Mich., controls the site.

MINNESOTA.

32. MISSISSIPPI RIVER. Near St. Cloud, Minn.. a fall of 25 feet can be concentrated and 10,000 horse power developed. The market is at Minneapolis, Minn., 53 miles; the site is controlled by Mr. E. F. Moore, of St. Cloud, Minn.

33. CROW WING RIVER. A fall of 22 feet and an output of 1,500 horse power at a cost of $80 per horse power can be developed 9 miles from Brainerd, Minn., which would be the market. The site is controlled by the Minnesota Water Works Co., Mr. Judd Wright, superintendent.

34. CANNON RIVER. At Cannon Falls a head of 40 feet can be secured and an output of 800 horse power developed at a cost of $60; the current can be marketed at Cannon Falls, two miles from the power site. The power is controlled by the Cannon Falls Light & Power Co., Mr. T. T. Comstock, Kenyon, Minn., manager. H. von Schon has reported on the project.

NEBRASKA.

35. Several large hydro-electric projects are being promoted with a view of supplying current to Omaha, which appears to be a very attractive market on account of the high price of fuel and the large amount of power used in packing houses, light, and traction plants. On the PLATTE in western half of Sec. 29, Town 17 N. R. 4 East, it is proposed to construct a diversion weir and head works and to locate from that point a 25-mile long open canal to carry 1,800 second feet; the head will be 125 feet and the output 18,000 horse power. Several large storage reservoirs are contemplated, and the service is to be restricted to 12 hours per day, resulting in the delivery of about 30,000 horse power for this period. Omaha is 35 miles from the proposed power house. The estimate of this development as prepared by engineers is $3.500,000. The

Fremont Canal and Power Co., of Fremont, Nebr., are organized to exploit this project, Mr. L. D. Richards, of that city, being the principal party in interest.

NORTH CAROLINA.

36. Catawba River. Three miles north of Hickory, N. C., is the Thornton power site, owned by Col. M. E. Thornton, of Hickory, N. C., with a fall of 26 feet, and immediately above are the Horseford Shoals with a fall of 44 feet, controlled by the Southern Power Co. A consolidated development of these two will give an output exceeding 10,000 horse power. This power can be developed in stages suited to the market; there is now a demand for about 3,000 horse power. The conditions quoted are as furnished to me by the owner of the site; I have not seen an engineer's report.

37. Catawba River. On the same stream, 15 miles from Charlotte, N. C., at Cowan's Ford, a fall of 30 feet can be secured by constructing a dam 22 feet high and diverting the flow for ¼ mile; 3,000 horse power can be developed and sold at Charlotte, N. C. The site is controlled by Mr. E. D. Latta, president, Charlotte Cons. Construction Co., Charlotte, N. C. The above data were furnished to me by Mr. Latta; I do not believe any engineer's report has been made.

38. Little Tennessee River. Near the Tennessee State line, the Craggy Lumber Co., J. S. Bailey & Co., of Swannonoa, N. C., Mr. S. F. Chapman, manager, own some 10 miles along the river, in which reach occurs a fall of about 225 feet, which can be developed in two sites: at the State line by a dam 127 feet high and 498 feet long, in rock location, and 6 miles lower down a dam 100 feet high and 500 feet long, also in rock. This project has received considerable attention and I quote from engineer's report the available flow at 1,780 second feet and the corresponding output 32,000 horse power, which it is estimated can be developed for $75 per horse power. The market for this must be found in Atlanta, Ga., 120 miles distant.

OHIO.

39. Sandusky River. The consolidation and modern development of several old mill properties at Fremont, Ohio, forms an attractive hydro-electric project. What was formerly the Creager mill at the city limits, the Hein & Brown mill just above, and the Tucker mill, now in commission, representing an aggregate fall of 40 feet, can be economically developed by two dams in rock location of 18 and 22 feet height respectively, each 300 feet long. The old Creager mill, a substantial stone building, can be re-utilized. This will yield an output of 2,000 horse power, all of which can be remuneratively served to industries now operating in Fremont, using over 3,500 horse power, or to the Lake Shore Electric Railway, operating lines from this point to Toledo, Cleveland, and Tiffin. The project is being promoted by the Fremont Power & Light Co., Mr. D. B. Love, secretary, at Fremont, Ohio. The author has made report on it.

40. Cuyahoga River, at the Falls. The available flow is said to be 200 second feet, subject to some lower stages and high-flood flow. The falls represent a total drop of some 150 feet, a considerable portion of which is now developed at three successive sites; these improvements are of the old type and can be economically consolidated in one development, with 60 feet fall, of

1,000 horse-power output. The cost of a plant would be low, as the river passes down a rock gorge 100 feet wide; probably it would not exceed $50 per horse power. The market for current is at the Falls. The property is controlled by Mr. C. M. Walsh, president, Hollow Staybolt Mfg. Co., Cuyahoga Falls, Ohio. No report has been made as yet.

41. Auglaize River. Near Defiance, Ohio, is a drainage area of about 2,500 square miles of medium ground-storage capacity, available flow probably 1,000 second feet subject to some lower stages, and a flood discharge of 5,000 second feet. A fall of 20 feet can be obtained with 13-foot high dam and one-mile diversion canal, yielding an output of 1,600 horse power at a cost of probably $80 per horse power. The market is at Defiance, 3 miles from the power site which is controlled by the Auglaize River Power Co., Hon. T. T. Ansberry, Defiance, Ohio.

42. Maumee River. At Perrysburg, Ohio, the river's drainage area comprises 6,500 square miles; the low flow is about 700 feet per second; flood discharge is high. A water power was developed just below Waterville, Ohio, under a special Legislative charter and operated until about 1887 but has since been idle. The dam, which was only 5 feet high, has disappeared; the canal which diverted the flow for about 4 miles remains in good condition. The river bed is in rock ledge; a head of 22 feet can be secured and an output of about 1,300 horse power. The market is at Perrysburg and Maumee, at the power site, or at Toledo, 7 miles distant. The opportunity is controlled by P. M. Puhl, of Maumee, Ohio. H. von Schon has made surveys.

PENNSYLVANIA.

43. Delaware River. The Walpack Bend is an oxbow in which the fall is 20 feet, and this can be increased to 40 feet by a 25-foot high dam above, the water being diverted across the peninsula through a tunnel about ¼ mile long. An output of 10,000 horse power is said to be available. This site is within 25 miles of half a dozen good sized cities in Pennsylvania and New Jersey, and only about 60 miles from New York. It is controlled by Mr. E. F. Peters, of Bushkill, Pike Co., Pa.

44. Bushkill. The noted Bushkill Falls have a vertical drop of 300 feet. This is about 2 miles from the power just described and is likely to be capable of a 4,000 horse-power development at an exceedingly low cost. This also is controlled by Mr. Peters and should be developed together with the Walpack Bend power, the two representing one of the most attractive remaining opportunities in that section of the country.

SOUTH CAROLINA.

45. Black Creek. Near Florence, S. C., a fall of 28 feet can be obtained and an output of 3,000 horse power, the market for which is at Florence, 3 miles, and Darlington, S. C., 8 miles distant. Florence is division point of three railroad lines and is a growing town, the region being one of the most fertile in the Pine State. The opportunity is being promoted by the Black Creek Power Co., represented by Mr. S. S. Ingman, of Florence, S. C. I understand an engineer's report has been secured; these data were furnished me by Mr. Ingman.

46. Broad River. In Fairfield County a power opportunity is offered of 31-feet fall. The dam would be 33 feet high and 900 feet long; the power sta-

tion could be in its interior. The project has received considerable engineering attention and a report has been made, from which these data are quoted. The flow is accepted at 2,500 second feet and the output at 6,000 horse power, which can be marketed at Columbia, S. C., 16 miles distant. The Central Carolina Power Co. controls the situation and Mr. A. E. Gonzales, president of the State Company, at Columbia, S. C., has furnished this information.

47. KEOWEE RIVER. A tributary of the Savannah River, in Oconee County, about 12 miles N. E. from Seneca, S. C., affords an opportunity to develop a 36-foot fall by constructing a dam 34 feet high and 250 feet long on rock ledge. Mr. Jas. Thompson, of Walhalla, S. C., owns the site and has placed at my disposal an engineer's report which credits the project with an output of 1,800 horse power, to be developed at a cost of about $100 per horse power. The market is at Seneca, S. C.

WISCONSIN.

48. WISCONSIN RIVER. There are several undeveloped powers of large capacity. At Mosinee the Little Bull Rapids create a fall of 20 feet; the flow is 3,000 second feet and the output about 5,000 horse power, which can be developed at a cost of $80. This power should be used for pulp grinding, as the pulp-wood supply is ample and transportation facilities good. The Joseph Desert Lumber Co., of Mosinee, Wis., control the power site. H. von Schon has made report on it.

49. CHIPPEWA RIVER. At Brunette Falls. The contributary drainage area comprises 5,000 square miles; the vertical drop is 10 feet and a fall of 35 feet can be secured very economically as the rock gorge is but 75 feet wide; 8,000 horse power can be developed at a cost of $65 per horse power, the market being at Chippewa Falls, 21 miles, Eau Claire, 31 miles; it is 90 miles to Minneapolis and St. Paul. The falls are controlled by the Cornell Land & Power Co., Chas. McArthur, manager, at Eau Claire, Wis.

This list presents no powers in New England and the Eastern States nor on the Pacific Coast where, as a matter of fact, the largest number of remaining opportunities are to be found; but while I have record and data of many, the line must be drawn somewhere. However, it would be unfair to close without mentioning the fact that Canada has within her borders undeveloped water-power resources exceeding those on the American side, though the best are yet on the outskirts of civilization and must wait for the pioneer and the track. I will mention one.

50. ONTARIO. MAITLAND RIVER, in the Georgian Bay district. Some 3 miles from the city of Goderich the Maitland makes a double turn and thus is created a power opportunity with a 78-foot fall and 3,000 horse-power output. The river's flow is remarkably constant, not subject to floods; the development is economically feasible. Current would be marketed in Goderich, which is a flourishing city with good harbor on Lake Huron and Canadian Pacific & Grand Trunk Railway terminals. The city has voted to guarantee half of the necessary bond issue to develop this power, which is controlled by the Maitland River Power Company, Mr. J. T. Goldthorpe, manager, Goderich, Ont. The project has been examined and reported on by the author.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By C. U. Carpenter.

V. MINIMIZING THE TIME OF MACHINE-TOOL OPERATIONS.

Mr. Carpenter's series began in January, and the four articles successively presented discussed, first, the general methods of examining into the condition of any manufacturing business so as to discover the existence of waste and loss and to determine the "sticking points"; second, the nature and the working of the "committee system" of factory administration; third, the reorganization of the designing and drafting departments; fourth, the great importance and value of the tool-room as a source and spring of profitable methods. He now reaches the very center of production in the machine shop—the operation of the machine tools themselves. The present article traces the general conditions necessary for manufacturing at minimum cost. A following and supplementary paper in July will show how the tests determining "standard times" for machining and for assembling can be made, and how the times so fixed can be introduced into routine operation in the shop.—The Editors.

TWO fundamental principles of cheap production lie hidden away amongst inefficient shop processes, bewildering disorder of shop conditions, and lax, inaccurate, and utterly misleading shop methods. They are of the greatest importance, and yet nine times out of ten a searching investigation will prove that little consideration has been given them in ordinary shop practice. They are so closely related that their simultaneous discussion is advisable. They are both essentially "time savers." These two principles are:

1.—The determination of "standard time" for each job, and its tabulation, introduction, and enforcement.

2.—The absolute elimination from the workman's routine of every duty but that of running his machine continuously and efficiently; the bringing to him of tools and stock for his next job before he is ready for it.

The first and possibly the more vital of the two is the determination of standard time upon each job—that is, the shortest space of time in which each job should be completed (including setting up), under normal conditions and with due regard to the fullest possibilities and capacity of the machine tool, the cutting tool, and the stock.

An appalling undertaking, this, in most shops, under existing conditions; appalling and seemingly impossible because of lack of knowledge as to the best shapes for cutting tools, the best methods of hardening and grinding, the results to be secured from the use of high-speed steel cutting tools, the best methods that can and should be adopted by a skilled workman, the total ignorance of the capacity of the machine tools in the shop, and, worst of all, the lack of men skilled in the best methods for handling these cutting tools—men capable of doing the work and of seeing that the workmen do it.

It scarcely seems necessary to argue in favor of this determination of standard time; and yet many manufacturers seems to prefer to leave the question of rapidity of production to the foreman's judgment and skill alone. Their confidence, while perhaps amiable, is usually misplaced. No man with real shop experience will assert that the average foreman does, or in fact can, know the best results that can be secured in machining today, unless he has been afforded and *has accepted* exceptional opportunities for making thorough tests of a really scientific character—something that rarely happens. Even should a foreman possess this desirable knowledge, it is beyond the power of any one man to supervise properly any group of men, even though small, so that the high point of efficiency may be assuredly reached, and at the same time do the other work that usually falls to the foreman's lot.

Again, the use of high-speed steel for cutting tools is a development of recent years. Notwithstanding all that has been published on this subject, comparatively few shop foremen really know what the fullest possibilities of its use are, and fewer still ever force their departments to use it to its fullest efficiency even after its value has been recognized. In fact, there have been comparatively few tables ever published that show in a practical manner just what can be done with it. The machine-tool builders themselves, singularly enough, seem to be unable to give any positive, accurate advice as to the actual conditions of cutting speeds, feeds, and depths of cut under which their own tools can best operate, and even the makers of the tool steels do not provide tables of much practical use.

Nevertheless the work of such a man as F. W. Taylor, in his remarkably thorough and extremely valuable publication, "The Art of Cutting Metals," clearly shows the possibilities that lie in the use of these modern cutting tools—Messrs. Taylor and White being the discoverers of these possibilities, and Mr. Taylor himself leading the van in the application to practical use of these principles. This one work makes clear not only the great possibilities but also the great difficulties that originally lay in the path of the investigator. With all of these points in mind, it is simply "rot" to give heed for a moment to any claim of any shop man that his knowledge of this subject is at all exhaustive.

Standard times should be determined by *some one, some how.* Certainly no one can dispute the fact. Experiments and experience show that the good old plan, "depending on the foreman" for this determination, as mentioned above, gives results 40 to 60 per cent short of maximum efficiency. Inasmuch as your entire business is built upon and depends upon the cost of production—or, in its last analysis, simply "the time it takes each man to do his job of work," it is of *fundamental importance* that that standard time be first determined by methods that will ensure accuracy.

The second cardinal principle of cheap production stated at the outset was "the absolute elimination from the workman's routine of every duty but that of running his machine continuously and efficiently; the bringing to him of tools and stock for his next job *before he is ready for it.*"

The machine hand, assembler, or other worker must be forced to concentrate his skill and attention upon his own work and that work alone, making it impossible for him to waste his time (and thus the employer's money) upon work he should not do. Consider for a moment the many things that a machine hand, for example, will ordinarily do other than operate his particular tool, and then give a moment's thought to analyzing the result. The worst "time wasters" can be classified somewhat as follows:

(a) Running to the supply room for stock for a new job, Result, the machine tool is shut down.

(b) Getting tools, clamps, etc., from the tool room for a new job. Result, the machine tool is shut down.

(c) Grinding his own tools (and very badly at that). Result, the machine is shut down.

(d) Excessive time in "setting up" a job, due to lack of proper instruction, or to a tendency to "soldier" because of lack of supervision. Result, the machine is shut down.

(e) To these add the further tremendous loss of output because the workman fails to use the proper—the very best—cutting speeds, feeds, and depth of cuts, through either lack of knowledge or lack of supervision, and you have a combination that cuts the output of the ordinary shop far below what it should be.

If your shop is running under ordinary foremanship supervision, with no thorough method for bringing to the workman his stock; for providing him with tools for the next job before he is ready for it; with no method of instructing him what to do and how to do it, and no thorough way of comparing his output with what it should be according to the best standards of today, (mark me! not your foreman's standards)—then you can make up your mind that your output is far too low according to the best standards of production.

You may imagine that "carefully calculated" piece-work rates will protect you; but if your piece-work rates have to allow for the conditions stated just above, you are deceiving yourself grossly as to the possibilities of your output.

The important consideration is time! time! *Time of the workman running his tool*—that is the vital point. Every minute counts for profit if this tool is operating continuously and efficiently, for loss if it operates under the nullifying influences detailed above.

Consider for a moment! Your entire factory investment—building, power plant, transmission plant, all probably built and selected with great care and expenditure of money—is simply to care for and operate the separate units of machine tools, or to properly house your assembling spaces. Your investment in machine tools represents large sums. This vast expenditure is made with but one object in view—that of producing work and producing it as cheaply as possible. Calculate accurately your indirect charges of every character; proportion the total against each machine tool according to the "machine-rate" method of apportionment, and note carefully how large must be the rate per hour for each machine. This will be found to be an astonishingly large proportion of the labor rate per hour and will prove a good index of the great cost of lost time in the shop.

Is it not clear, then, that each machine tool should be, nay *must* be, brought to *as high a factor of operating efficiency* as possible? Is not your entire investment made with that one end in view? Does it pay to have the efficiency of any collection of these units reduced 15 per cent to 25 per cent by the existence of such shop methods as those detailed, by which the men operating the machines are actually compelled to shut them down to hunt up their next job, to collect their tools, to grind their tools, and do many things that should be done for them? Can you afford to suffer an even heavier reduction in efficiency due to lack of knowledge of the "best time for each job?"

The importance of these points can be further emphasized by considering that all such delays, which in their total represent a large amount, directly affect cost and profits, output, indirect expense of every description, quick movement of stock, and hence ultimately the amount of working capital needed in the business, and the possibilities of quicker deliveries, with a resultant direct effect upon the sales department and customers. Indeed, aside from the question of costs and profits, nothing is more important to the separate members of a company, from the executives with their financial problems, through the sales department with their selling problems, to the harassed factory manager, than the quick movement of stock.

The reason for the continual absorption of working capital into machinery or stock that worries many a financial officer, or for deliveries so delayed as to affect seriously the efficiency of the. selling organization, or for excessive and unreasonable and possibly unexpected costs that seem and, in fact, are out of reason—the reason for all lies hidden away back in the shop processes and methods. It crops out at the individual lathe, planer, shaper or assembling bench, and then only to the keen experienced eye. The workmen busy? Surely. Look at them hustling! But—see that group around the tool-supply window waiting for tools? How many are waiting at the tool grinders to grind their own tools each in his own "individual" manner? There is a mechanic who has taken twenty minutes to "set up" his job instead of ten. Then pause and wonder how in the world any one or two or more foremen can be sure that the men now operating the machines are using proper speeds and feeds and getting the most out of the machine and the tool.

In fact, the causes for all these serious troubles are located so far back toward the fundamentals of production—the individual units affording the causes are so seemingly unimportant, and such is the difficulty of recognizing these conditions, buried as they are in a busy shop—that they are overlooked or ignored.

As a general proposition, the greater the difficulty of solving such problems the more important and necessary becomes that solution, simply for the reason that in this you are dealing with human elements to whom is given the opportunity of slowing up in production solely because of that very difficulty that lies within the problem itself and its solution. And yet so fundamental and vital is their importance that they cannot be ignored.

The Starting Point for Standard-Time Determination.

Investigation of Existing Machinery.—Any plan for the introduction of proper methods for the determination of standard time and the elimination of wasted time must begin by an investigation of the existing shop machinery—an individual report upon each machine tool, especially touching upon the defects, and a recommendation as to what types should be purchased in the future to meet modern production requirements. This is a matter of great importance, but often overlooked. Unless the needs of the shop in the way of modern machinery, designed to stand up under the latest high-production requirements, are recognized and listed up at the beginning of the introduction of any new plans, this important matter is liable to be lost sight of later, with the consequence that when the time for purchases of new machinery does come, the older inefficient types are clung to and the shop is further encumbered with old-style tools.

Nor is the question of securing a more rigid and efficient tool such a simple question as at first appears. Few machine-tool manufacturers are making an earnest attempt to place upon the market tools strong enough to meet the more severe requirements of today. Why? First because comparatively few have made tests of sufficient scientific worth to determine where the points of greatest weakness really are and how to strengthen them properly. Second—there is the money tied up in old patterns, old stock in the factory bins, in machines going through the pocesses of manufacturing, and finally in finished machine tools carried in the sales rooms. Changes of a radical character would prove a serious matter under such conditions. And, again, the demand of the manufacturer for better and heavier tools has not been urgent enough to force the machine-tool builder into the tremendous trouble that a thorough redesigning of the older types would surely cause. Therefore the latest product of a machine-tool manufacturer is not necessarily adapted to the methods of production that I am advocating.

Greater driving power is usually the first requirement. Accurate tests have shown that modern lathes, for instance, should have fully double the driving power usually contemplated in their design. This is a point that must be considered carefully. Of course a proper increase in driving power of a lathe, for example, means wider cones, heavier bearings, and stronger heads. Immediately there follows the question of the rigidity of the bed. It is at once apparent that this is a very important point, and yet too little attention has been paid to the design of bed best suited for withstanding the strains and stresses due to the use of new high-speed cutting tools. Solidity is very necessary. The consideration of the need of strength and rigidity should certainly be applied to the tail stock. Slide rests and tool holders should be simple and strong. The tool must be held rigidly under all conditions. The tool posts should be set down lower than is customary in every-day practice. Under modern conditions much greater feeding power is needed.

But however certain we may be that defects in machine tools have a direct effect upon the rate of production and the cost of the product, existing conditions may prevent purchase of new tools. Inasmuch as I have been through the mill several times with run-down concerns, I appreciate fully the fact that most manufacturers are obliged, through sheer financial stress, to ignore any scheme, no matter how promising, that involves at the outset a thorough replacement of the existing machinery with the most modern types, even though it can be demonstrated that the latter are 50 per cent more efficient.

The practical question that confronts many a manager is: "What on earth can I accomplish with my *present old* 'rattle traps' of machine tools? I couldn't buy gold dollars for 98 cents if I had to pay cash, much less spend thousands for replacing my present machinery. *I must first make good with what I have.* After we are on firm ground we'll talk about stronger and better machine tools."

True! Very true! A viewpoint very often overlooked by the manager, or by the man who has this work in charge but doesn't have to produce the dollars to "keep the old ship afloat." This latter situation, which is a stern actuality with many a man who is eager to improve conditions, is all compelling and must give shape to the preliminary methods of procedure. This I shall try to keep in mind.

Granting, however, the hard fact that many concerns are obliged first to dig out the problem, using their existing facilities, it is of all the greater importance that two reports relative to machine tools be made out:

First, a report showing what heavier, stiffer, and more efficient types of machines should be substituted for existing types when the proper time comes.

Second, a full report upon each and every machine tool in the shop, showing its points of weakness and its limitations in cutting speeds, feeds, and depth of cuts; how it can be strengthened; a description of the kind of work that should be done on it; a record of best times on jobs; a full statement of the best machine tool to substitute for it, and a clear-cut comparison of possible production by the use of the latter machines.

I warn you again that unless this be done systematically *at the start,* it probably never will be done; then as time goes on you will find yourself burdened with many a newly purchased machine tool just as weak and inefficient as the older one it replaces.

In considering the problems of increasing production in any particular shop, we find therefore that they become problems of devising methods and making tests upon the supposition that existing machines and facilities must be used in regular production—that, however advantageous the later types of tools, the important question of lowering costs must be considered on the basing of developing to the uttermost the efficiency of the present machinery. We must therefore keep in mind these points in the building up of our system. The great importance of gathering all our data systematically and of using them scientifically cannot be too strongly insisted upon.

Possibilities Underlying the Use of High-Speed Steel.

Closely linked with the study of the design, character, and remodelling of the existing machine tools, is the second great step in the betterment of machine processes—the use of high-speed steel cutting tools.

The possibilities underlying their introduction and full employment have been thoroughly discussed by other writers and proven again and again in every-day shop practice where thorough methods have been adopted. It is sufficient to say that the increase in production over that secured through the use of the older carbon steels may be expected to reach from 40 per cent to 85 per cent (depending upon the character of the metal being cut) if the machine tools are in proper condition to withstand the strains of the increased cutting speeds, feeds, and cuts. If the shop under consideration is in a run-down condition, and there has been lack of system in shop processes as well as lack of efficiency in production methods, a much greater increase than 90 per cent may reasonably be expected. I have noted myself records of over 200 per cent increase in efficiency and output, and have been shown records in a number of cases that exceed 300 per cent. Of course to anticipate such large increases in all cases would be foolish, but there are many cases today where such results are well within the range of possibility. Such a prize is well worth fighting for.

The Determination of a Proper and a Standard Shape for Cutting Tools, the Supply of a Sufficient Quantity to Avoid Lost Time.—This is the first point of attack. Before another step is taken these standard tool shapes *must be determined* and *must be rigidly adhered to.* The old tool dresser, who is in all probability totally ignorant of the proper shapes of tools as determined by scientific experiments, and probably stubbornly sticking to his "home-made" knowledge of hardening the modern tool steels, must be eliminated. The practice of allowing a hundred workmen to grind their tools in a hundred different ways must positively be stopped.

In place of these haphazard, inefficient methods must be substituted those that will lead to the adoption of standards proven by experiments and experience to be efficient, and these must be adhered to without deviation.

In view of the differing opinions of factory men upon the subject of proper shape of tools, it is fortunate that we can refer to the results of and deductions from the experiments of Dr. Nicholson, and later, and indeed especially, to those of Mr. F. W. Taylor of Philadelphia, as guides which can safely be followed. The latter tests of Mr. Taylor are especially exhaustive and convincing. The results of the tests performed in a modest way under my direction are confirmed by Mr. Taylor's data. The limits of this article prevent any lengthy discussion of the many important points to be observed; they must be skeletonized only.

1.—In determining the most effective shape for any tool, such as for instance a lathe tool, careful consideration must be given to the fact that limitations may have to be placed upon the shape which would provide the greatest cutting efficiency, by the necessity of considering the difficulty and cost of forging and grinding. These costs may prove such as to require a modification of the type which *per se* would be the most efficient.

2.—The dynamometer tests by Dr. Nicholson demonstrated the fact that a tool with lip angle of 54 degrees (cutting angle 60 degrees, clearance 6 degrees) would remove soft steel at a low degree of pressure. Such an acute angle, however, can hardly be considered for commercial use, because of the danger of crumbling. He established the fact, however, that we should generally adopt the sharpest angle of cutting tool that would not crumble under the strain of working conditions. His tests showed that on medium cast iron cutting angles should be 76 to 80 degrees (with clearance of 6 degrees) and consequently their lip angle should be about 70 to 74 degrees. His tests upon soft steel were not conclusive because of working conditions, but the tests he made indicate that a cutting angle of about 70 degrees (lip angle 64 to 65 degrees) lasted the longest time in rapid cutting.

Mr. F. W. Taylor's tests show that tools for cutting softer steels should have a clearance angle of 6 degrees, back slope of 8 degrees, side slope of 22 degrees, or a lip angle of 61 degrees. For cutting cast iron and harder steel the tool should have clearance angle of 6 degrees, back slope of 8 degrees, side slope 14 degrees, or a lip angle of 68 degrees. On harder steel a clearance angle of 6 degrees, back slope of 5 degrees, side slope 9 degrees, or a lip angle of 74 degrees is recommended. On chilled iron a lip angle of 86 to 90 degrees is recommended.

Great care must be exercised to see that the point of the tool is blunt to such a degree that crumbling cannot occur. The round-nose tool with a large radius of curvature has been adopted by me as the best of its type, although straight broad-nosed tools can at times be used to good effect. As regards the question of side slope vs. back slope I favor steep side slope, though guarding to the utmost possible against gouging into the work. A combination of these two can be secured that will produce good results..

This question of shapes of tools must be thoroughly thrashed out and settled by the expert and the committee before another step is taken. Decide upon your standard types. But whatever types are decided upon, by all means adopt a few set rules in regard to tools, and stick to them.

First. Reduce your sizes of tools and the types of tool steel to a minimum.

Second. Adopt standard shapes and then don't change them.

Third. Stock up your tool-supply room with plenty of small tools. Keep the workmen supplied.

Forging.—The final standard shapes of tools having been decided upon, then take up the important question of the proper forging of the tools. Here is where vigilance should begin. In the first place, limit gauges will pay. Your tools must be forged to the correct shape and in such a manner as to reduce the preliminary grinding to a minimum. The shapes must be considered with care so as to provide for cheap and effective tool grinding after the tool begins its life of usefulness. Naturally the conclusions reached in the consideration of standard shapes will influence very largely the methods of forging. Do not run the risk of starting cracks in your tool steel by nicking it and breaking the pieces off cold. In heating the tool do it slowly so that the heat will have ample time to penetrate the entire bar. Unless this is done cracks may develop. Bring it up to a light yellow.

Methods of Hardening.—Considering the large volume of good information now available as to the best methods of hardening high-speed tool steel, it is strange to note how often we find the toolsmiths adhering to plans of their own.

It is of great importance that your toolsmiths should be given to understand that any adherence to the old "color" ideas in the processes of hardening must be absolutely abandoned, and that the newer methods of hardening recommended by the makers of tool steel must be absolutely followed. At one time the methods described by the makers were unnecessarily complicated, in order to throw a certain degree of mystery around the processes, but of late the tendency has been toward a decided simplification.

It is highly desirable that the number of grades of high-speed steel used in a shop be reduced to as low a number as possible—certainly not over two, and, if possible, one—and that a thorough standard method of hardening be adopted, and adhered to. Owing to the tendency of the ordinary toolsmith to slip back into his old slipshod ways, it is important that some accurate record of his hardening processes and some check be kept upon him, especially during the period when practical methods of hardening are being introduced and thoroughly standardized. The record need be only a simple one, but must be sufficient to enable you to trace unerringly any defects appearing in the tools due to bad process of hardening, and to center the responsibility for these mistakes upon the toolsmith responsible for them.

I therefore suggest the following form for keeping hardening and tempering records:—

HARDENING RECORDS.

Date ________________

Tools	Size	Quality of steel	Lot No.	Remarks

Hardening Heat Temperature.
Cooling Agents.
Tempering Heat Temperature.
Toolsmith.________________________
If defective, Why?____________________

FORM FOR HARDENING RECORDS.

The methods of hardening lathe, planer and boring tools are fully described by the makers. Generally the forged nose of the tool is placed in a well-burned-through coke or coal fire, and brought slowly to a white welding heat. This heat should be raised to a point where the nose begins to soften. Care should be taken to see that this heat extends over fully three-quarters of an inch of the nose. At this fusing heat, the white-hot part should be put immediately under the strongest and coldest air blast which is available, compressed air being the best to use. Under no circumstances must the tool be brought in contact with water while it is hot. It is probably preferable to harden the white-hot nose of the tool in fish or lard oil until it grows moderately cool, and then to continue the cooling-off under a cold blast.

Mr. Taylor, in his description of the heat treatments, brings out the important feature that the nose of the tool should be heated *slowly* to a bright cherry red, so that the heat may penetrate to the center of the tool. From the bright cherry red up to the melting point, the tool should be heated as rapidly as possible in an intensely hot fire until the nose of the tool begins to soften. He urges very strongly the importance of using an intensely hot fire for the second period of heating.

The cooling of the tool should be done rapidly until it is below 1,550 degrees F. From this point it makes little difference whether it is cooled rapidly or slowly. Mr. Taylor advises the use of a bath in red-hot molten lead in bringing the tool down below a temperature of 1,550 degrees.

In his article on the "Art of Cutting Metals" he brings out the advantage of the second or low-heat treatment, which is obtained by re-heating the tool which has had the high-heat treatment to a temperature between 700 and 1,240 degrees F. Great care, however, must be used to see that the higher temperature is not exceeded, for should this happen the quality of the tool will be seriously affected.

For the heating of special form tools, milling cutters, etc., special methods are of course necessary, the use of the ordinary coke or coal fire being out of the question. Where a number of these parts are heated at a time, great care must be taken to see that they do not touch one another. Special furnaces should be used. These can now be purchased for a reasonable figure. In these furnaces the work can be properly suspended so that separate pieces will not come in contact with one another, and accurate control of the heating can be secured with the aid of a pyrometer.

Grinding of Tools.—As was pointed out under the heading of shapes of tools and forging, it is necessary to determine these shapes with care so that the cost of grinding the tools will not be excessive.

It seems hardly necessary to assert the importance of having all tools ground in one place and according to standard shapes. There are, however, a surprising number of shops still left in which the workmen are allowed to grind their own tools in their own way. Inasmuch as tests show that the shape to which a tool is ground will affect its efficiency to a very high degree, it is perfectly obvious that such a plan as allowing the workmen to grind their own tools is simply ruinous, to say nothing of the question of wasted time on the part of the workmen.

We must, of course, assume that under the heading of shape of tools the manufacturer has determined just what grinding angles should be adopted throughout. It is of much importance that these angles be rigidly adhered to, not only because they will prove the most efficient, but also because all the tabulations which any one may make up for any particular shop will be based upon these standard shapes and consequently any variation from these shapes will tend to vitiate the records and so annul the good points of the determination of standard time.

In my opinion, all grinding of tools should be done by automatic machines, so that all angles can be ground uniformly. If, however, this grinding is still to be done by hand, it is very important that you get a thoroughly skilled man and watch him with extreme care, especially at first, to see that he will adhere to your specifications for grinding angles. If you do not watch him, he is almost certain to slip back to methods of his own or to adopt those of other men in the shop. If this grinding is done by hand, then provide the tool grinder with proper templates and tables so that the possibility of mistakes will be eliminated as far as possible. Such is the importance of grinding these tools accurately, however, that an automatic machine grinder will be found almost necessary.

Overheating of the cutting tool during grinding is one of the greatest causes of deterioration of quality. Caution is generally impressed upon the people handling these tools, and it can not be urged upon them too strongly. Many a tool apparently in good condition has been ruined by overheating in the grinding operation. The tool should be moved continually. A cooling agent directly on the nose of the tool should always be used. Many makers of high-speed steel state that while grinding on a dry wheel may be done, at the same time *great care must be taken* to see that the tool *is not discolored, i. e., overheated.*

I concur in the statement of Mr. Taylor that on the average a lathe tool should be so operated that grinding would be required at the end of an hour and a half, going, of course, upon the presumption that the tool is of standard, high-grade quality. In many of the tests on which records have been presented and in the data which are always submitted by the high-speed steel manufacturers, we find a continual reference to the length of time a tool runs without regrinding. This, however, is of very little interest to the average manufacturer, as the question is not how long a tool may run without regrinding, but how much should a tool be forced so as to produce the most work with a minimum expense for grinding, keeping in mind at all times that the crowding of the machine tool is the important consideration. The question of how long a tool may run without regrinding sinks into the background, especially if the grinding of a tool may be done in a scientific manner by automatic grinders.

The use of cooling agents, such as soda water, is highly desirable. An increase in production of 35 per cent on medium and soft steel can be secured through the use of a properly directed heavy stream of water.

Finally, let me urge the necessity of keeping a large supply of tools already ground up in the tool-supply room, so that, under no circumstances, will the workman be compelled to wait for his cutting tools. This is an important point and is often overlooked.

The Determination of Standard Time.

To sum up, then, the standard times for any shop depend upon the following:

1. The character and limitations of the existing machine tools.
2. The introduction and use of high-speed steel for cutting tools. This will include:—
    - (a) The determination of the proper shapes for tools.
    - (b) The provision for proper treatment of steel of this character in forging, hardening and grinding.
    - (c) The determination of the best working conditions possible, such as the cooling agent, etc.
3. The securing of the maximum possibilities in cutting speeds. This includes:—
    - (a) The careful consideration of tests already made and submitted by different investigators, giving of course due thought to the conditions existing at the time of the test.
    - (b) The adaptation of these records to existing shop conditions and the making of thorough tests in the local shops under the limitations imposed by types of machine tools existing in the shop.
4. The collation of all production data upon a systematic plan and their arrangement so that they can be used.
    - (a) The instruction of the foreman and the workman as to the results to be expected and how to secure them.
    - (b) The insurance that the every-day production follows closely this standard of efficiency.

The first and second sections have been discussed in the present article. The third and fourth—that is, the fixing and the practical introduction of standard times—will be taken up and explained next month.

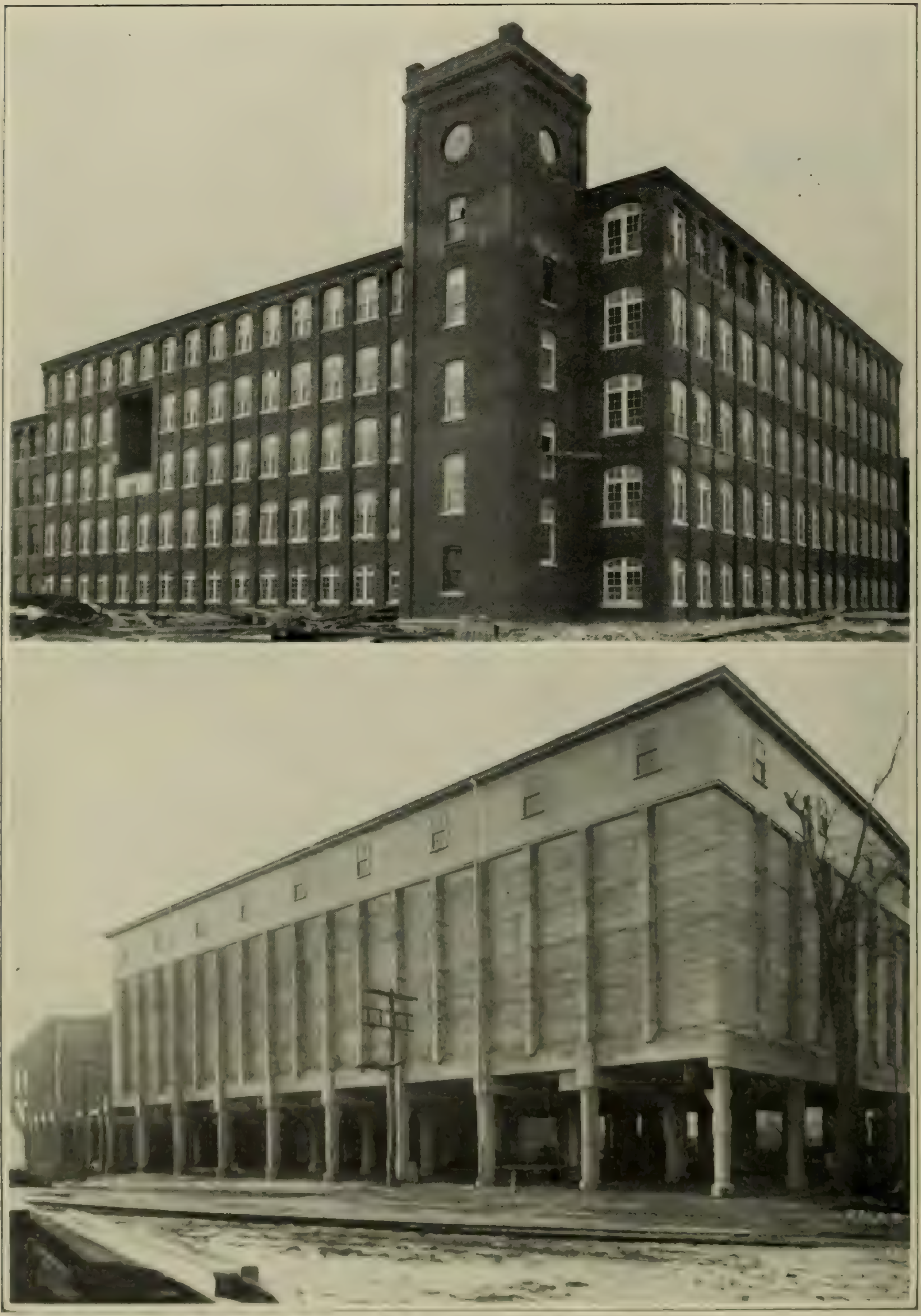
REINFORCED-CONCRETE STRUCTURES FOR MANUFACTURING PURPOSES.

By Leonard C. Wason.

The vast extension of the use of steel as a structural material has become so familiar to our observation that the wonder of it is overlooked. And now, closely associated with it and in part dependent upon it, comes another great phenomenon—the even more rapid rise of concrete-steel for all forms of construction. The peculiar advantages of this mode in stability, fireproofness, adaptiveness to design, and conformity to many of the requirements of manufacturing buildings, make it highly important to the industrial manager or owner who is contemplating the erection of new plant or extension of old. It is from this broad viewpoint that Mr. Wason considers the subject. Following articles in THE ENGINEERING MAGAZINE by specialists in this branch of engineering will discuss other phases.—THE EDITORS.

REINFORCED concrete is not a new building material. Twenty-five years ago, a number of large buildings, including some for manufacturing purposes, were built of reinforced concrete in and about San Francisco, and all these structures appeared among the buildings which most successfully withstood the earthquake and fire of 1906. The uses of concrete have been increasing and the variety of its applications have been widening ever since. Gradually its merits and advantages have gained general recognition, until within the last few years so many structures have been built as to attract almost universal attention. The comparative shortness of the time within which attention has thus been generally centered on this type of construction has led to an erroneous impression. The fact is, however, that the full test of time and trying out of the various types and applications through severe experience have today enabled it to hold a front rank as a building material, unquestioned by those who have had experience in its use, and commanding the confidence of all.

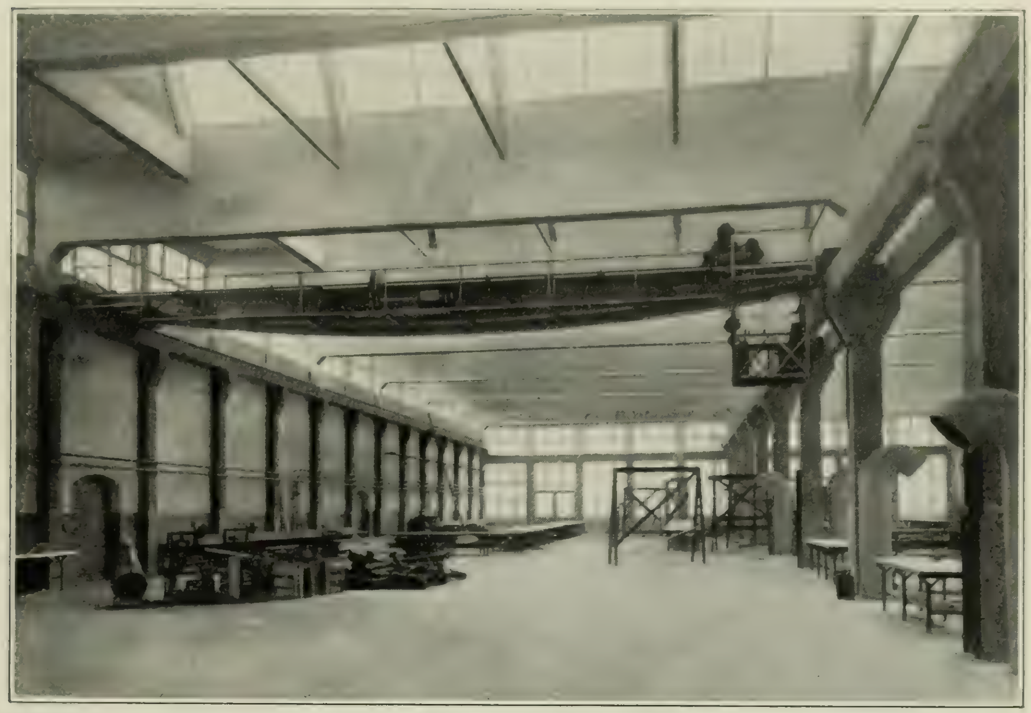
The general principles of design and construction have changed but little in these twenty-five years. There have been a number of changes in details dictated by the experience gained through use, which developed all the possibilities and demonstrated the few limitations of reinforced concrete, and changes also based upon the knowledge obtained by the large amount of experimental research in the laboratories of many technical schools upon the physical properties of the combination of steel and concrete; so that today designs can be as accurately made and results as confidently guaranteed as is possible with brick, stone, wood, or steel construction.



ABOVE, SPECTACLE SHOP OF AMERICAN OPTICAL CO., SOUTHBRIDGE, MASS. BELOW, COAL POCKETS AT HARTFORD, CONN.

Reinforced-concrete construction, by the Aberthaw Construction Co., Boston. The coal pockets are of 2,000 and 8,000-tons capacity. The roof of the large pocket only is of wood. General plans for these were made by Adolph Suck, Boston; structural plans by Aberthaw Construction Co.

The only reason for the introduction of a comparatively new building material is the fact that it is either cheaper than existing modes of construction, or if not actually cheaper, is so far superior to existing methods in the results obtained as to justify its use. In the case of reinforced concrete it is only necessary to refer to the nearly universal application to prove economy. A few specific illustrations will emphasize the point.



ASSEMBLY BUILDING OF THE PIERCE AUTOMOBILE FACTORY. REINFORCED CONCRETE. Two 3-ton cranes run on all-concrete girders. The saw-tooth roof is shown from the lower side. Kahn system; constructed by the Trussed Concrete Steel Co., Detroit. Lockwood, Green & Co., architects.

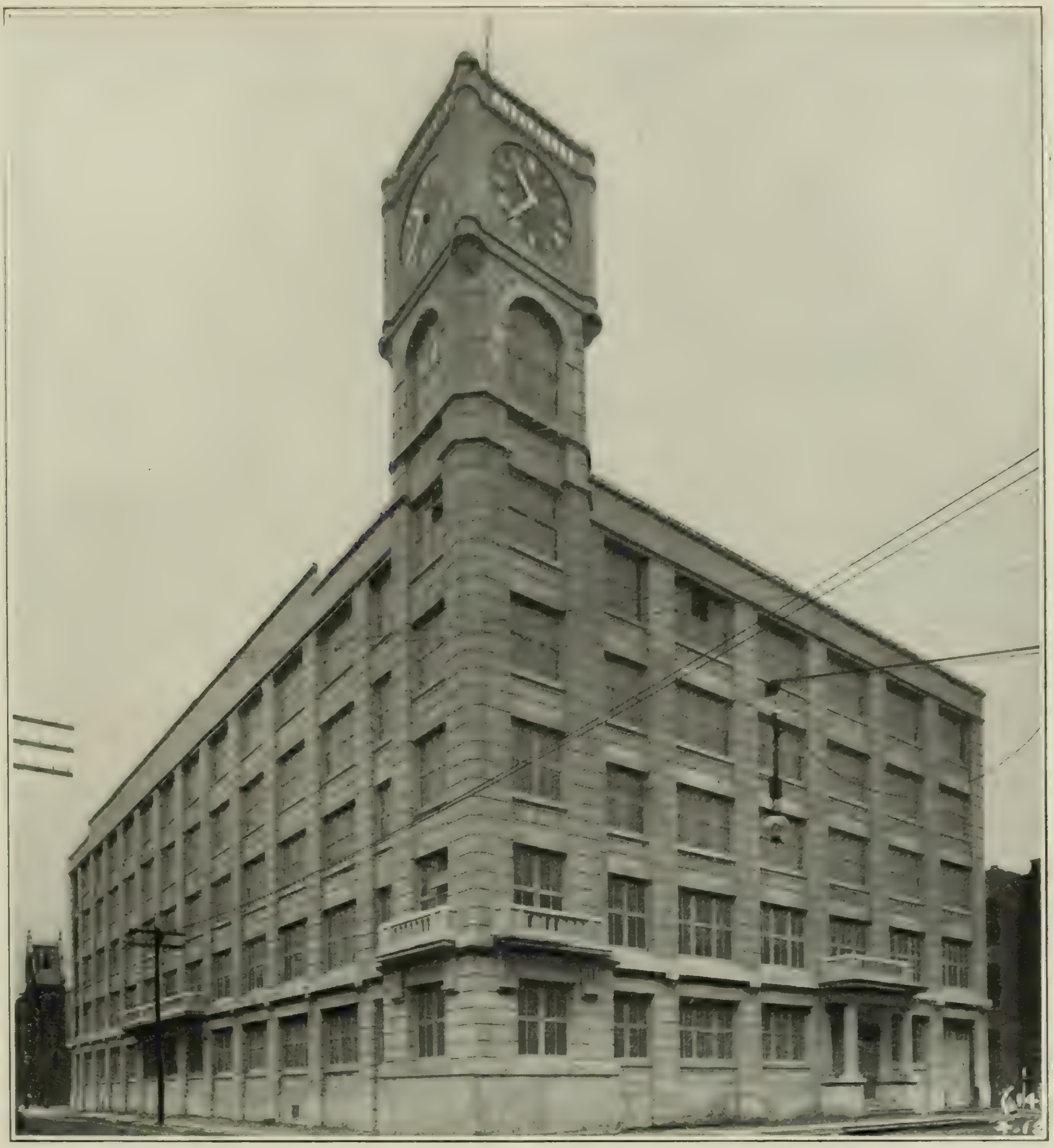
Concrete of the usual mixture (1:3:6) has three times the working strength of the very best brick work and seven times the strength of ordinary, common brick work. Therefore, for columns, very much heavier loads can be carried on a given section, or smaller columns can be used, thus making a saving in floor space and in walls permitting larger windows to be used. With floors, longer spans are possible, giving a freer floor space. The beam between the wall columns can be set above the floor slab, thus allowing the windows to be set higher, and at the same time forming the wall below the sills of the next story. Reinforced-concrete floors are very much more rigid than those of wood or of steel. Being built monolithic in large sections with granolithic top, they are both germ and waterproof. There is no decay as with wood, but instead the cement becomes stronger with age. There have been long-time tests of cement showing a measurable increase for seventeen years.

These floors are also very poor conductors of heat, thus reducing condensation when there is heat and moisture on one side and cold on the other side of either floor or wall. Sounds cannot be heard through the floor so readily as through wood.

In textile mills, where there are long spans and light loads, the wood floor of standard mill construction is cheaper in first cost than concrete. Nevertheless, concrete is used on account of other advantages, which offset the slight difference in first cost. The agent of a large textile mill stated that looms running on the fourth and fifth stories of his mill, which was of the usual mill construction, caused such vibration that it was considered unsafe to run them at full speed. This reduced the output. When they were transferred to the lower stories the output was increased by 20 per cent and in addition there was a saving in the wear and tear on the machines, and in the power required to drive them. Vibration cannot occur with a rigid floor tied to the columns so that every support becomes a rigid brace. The Paris & Orleans Railway tested a steel beam and terra cotta floor by dropping a heavy weight on it and measuring the amount of vibratory movement and the length of time it lasted. A reinforced-concrete floor of the same span and weighing but little more than one-half as

BAYONNE REFINERY OF THE PACIFIC COAST BORAX COMPANY.

The original building included one story of the portion in the foreground, with the four-story structure at the extreme right. The addition is the four-story portion surmounting the older one-story part in the front of the picture. Reinforced-concrete, built by the Ransome & Smith Co., N. Y.

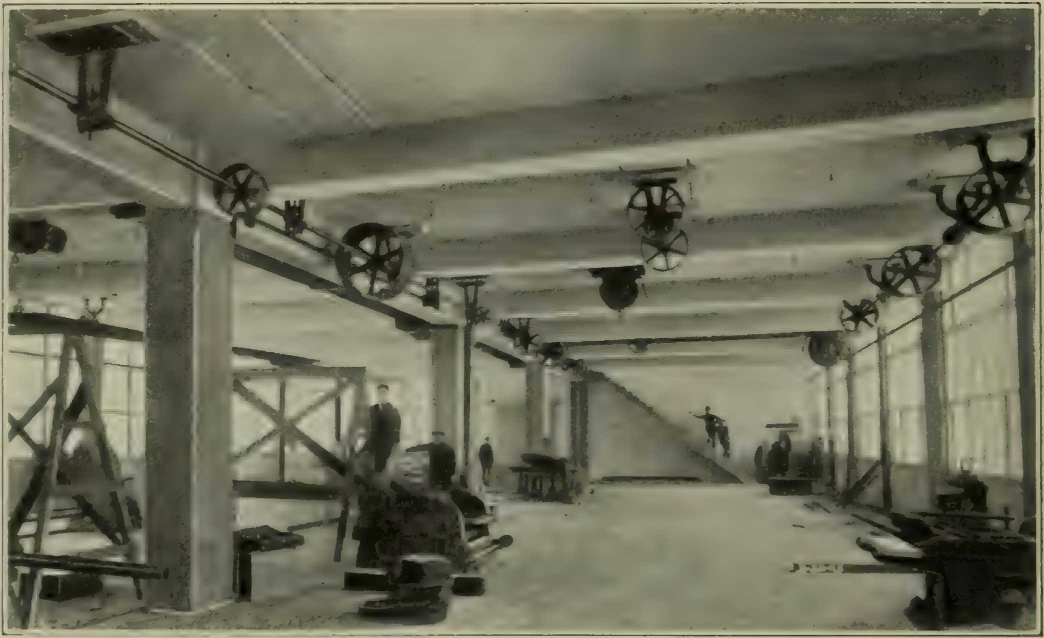


CONCRETE-STEEL MANUFACTURING BUILDING ERECTED BY KEUFFEL & ESSER CO., IN HOBOKEN, N. J.

Louis Meystre & Son, architects. Built by Turner Construction Co., N. Y.

much had materially less movement and the vibration lasted a shorter time.

Wood floors in dye houses are subject to rapid decay from alternate wetting and drying and from the steam escaping from the tanks. On account of the waterproof quality of concrete floors and their proof against deterioration from moisture, a great saving can be made by their use. In some dye houses condensation of steam on external brick walls has caused their rapid distintegration. Concrete walls which are much less porous than brick and therefore have very much less absorption, have been found enduring and on account of their poor conductivity, condensation on the inside of solid walls, even, has been overcome. Because of the density and impermeability of con-



FIRST FLOOR, BODY BUILDING, AUTOMOBILE PLANT OF THE GEORGE N. PIERCE CO., BUFFALO.

The building is 60 ft. wide, with two 30-ft. bays. Attachment of shafting and motors to ceiling is well shown. Built on the Kahn system by the Trussed Concrete Steel Co., Detroit.

crete, tanks, vats, and filters can be built nearly as cheap as those made with the older building materials. It is possible to make the surface proof against the attack of dilute acids and of all alkalies or salts.

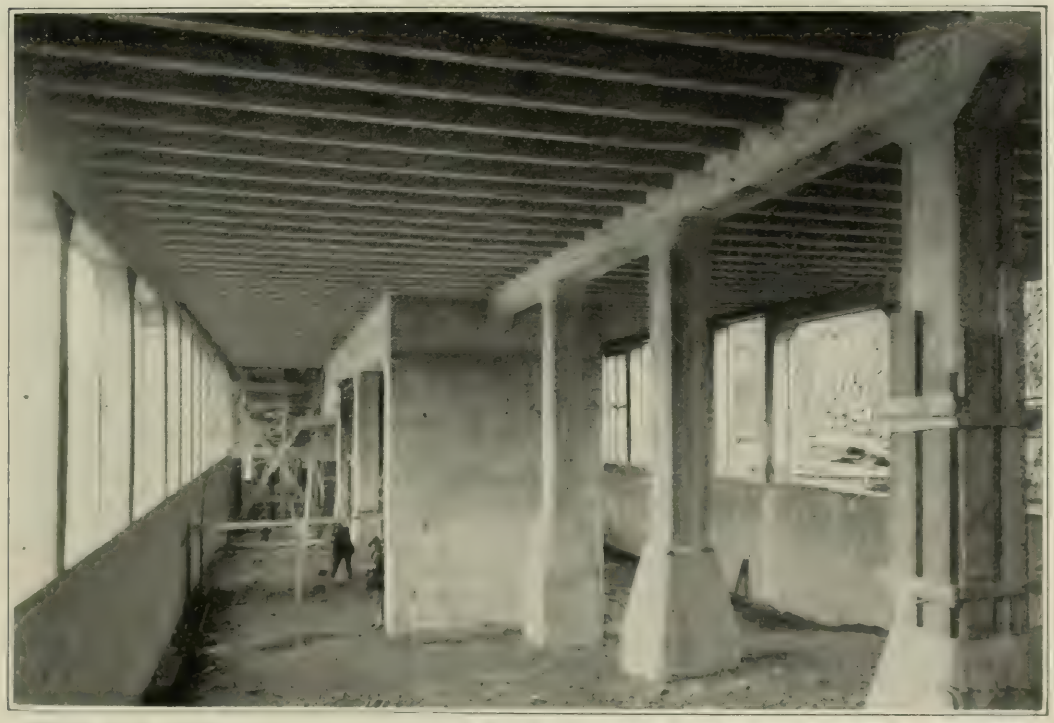
This construction is especially adapted to heavy loads—the heavier, the greater the advantage to be obtained in price over wood. The heaviest floor yet built sustains a live load of 5,000 pounds per square foot on a span of 14 feet. In machine shops and foundries where the loads are from 250 to 500 pounds per square foot there is some advantage in first cost, while the greater rigidity enables the machines to run without vibration, thus enabling better work to be done and adding to the life and reducing the repairs necessary to the machines themselves. The floor is not affected by mineral or vegetable oils which may be spilled upon it, and is non-absorbent so that it can be easily cleaned. Machines may be bolted through the slab of the floor without much difficulty. There are several convenient methods of attaching hangers for shafting to the ceiling. The best way is to embed bolts in the beams, projecting below a proper distance to receive wooden strips or steel channels to which hangers for shafting may be attached. This gives opportunity to attach the hangers at any point desired.

In jewelry factories, fine particles of gold dropped on the floor can easily be lost between the cracks of wood, but are readily recovered from a hard, smooth granolithic surface which has no joints.

The sanitary quality of these floors makes them of unusual advantage in factories where food products, such as meat, fish, and fruit, are handled; a scrubbing brush and hose render the floor as clean as when new with no danger of leakage to spoil goods in the stories below. For this reason hospitals for contagious diseases are also built of reinforced concrete. It has also been used for cold-storage warehouses because of its non-conducting qualities, and because also it is so easy to make the walls and floors hollow, still further reducing the conductivity. The tuning rooms in piano factories have been built with the hollow construction on account of its sound-proofness.

Where unusually heavy loads must be carried, say 1,000 to 1,500 pounds per square foot, as in coal pockets where coal teams drive underneath to load, concrete is considerably cheaper in first cost than wood.

In the power development of any plant there are many valuable applications. A large chimney can be made much cheaper of concrete than of brick, because it can be tied together to resist unequal stresses due to temperature, thus permitting lighter sections to be used. As it will withstand for an indefinite period a temperature of 500 degrees F., fire-brick linings can be omitted. The chimney is tied to its foundations and thus has greater stability than one of brick. In



UNDER SIDE OF FLOORS, ANDROSCOGGIN PULP COMPANY'S FACTORY, SOUTH WINDHAM, ME.

All reinforced concrete, by the Aberthaw Construction Co., Boston, from plans by I. W. Jones, Milton, N. H.

spark arresters where there is an elevated chamber, in which the sparks are extinguished by a water spray, the chimney can be suspended from the roof of this chamber without much difficulty. In the engine room the dead weight of concrete, which is greater than that of brick, makes it an excellent material for foundations for heavy horizontal engines, while at the same time it is much cheaper than brick; and being proof against attack of oil, it cannot disintegrate. In water-power development, the reinforced gravity dam has greater stability than the solid one. It is more stable with a freshet than when the pond is three-quarters full. Yet it has very much less material in it than the solid dam, it is quicker and cheaper of construction, and it can be made perfectly tight. In some cases the space under the dam has been used for the power-house, thereby saving room and cost of a building. Holes are cored through the buttresses supporting the up-stream face of the dam and a perfectly dry passageway may be built across the stream.* Penstocks can be made watertight and will last indefinitely without deterioration. Numerous experiments have been conducted on the danger of corrosion of steel embedded in concrete, and it has been conclusively proved that even if the concrete admit water the steel does not corrode if there is no current, and that rusty bars thoroughly coated with cement will after a month's time become bright and remain so.

High retaining walls have been built with a thin vertical wall tied to a broad base by means of counterforts at a cost one half that of solid masonry, at the same time having greater stability.

Our forests are being rapidly cut off, and the timber which remains is of inferior quality to that cut several years ago; there is difficulty in getting large sticks of yellow pine; all this renders floors of mill construction less secure and more expensive than they have been, making less difference in cost than there used to be between wood and concrete. On all-fireproof buildings, lower rates of insurance can be obtained. On a building of Merritt & Co., Philadelphia, where light iron work is manufactured, the rates on building and contents, which had been 3.57 per cent on their old building of mill construction, were reduced in the new fireproof structure to 1.82 per cent, a saving of 1.75 per cent per annum. This, considered as the interest on a permanent investment, would warrant an expenditure of a much larger sum than the actual difference in cost between mill construction of wood and brick and fireproof of all reinforced concrete. Moreover, the immunity from fire, avoiding loss of business and interruption of

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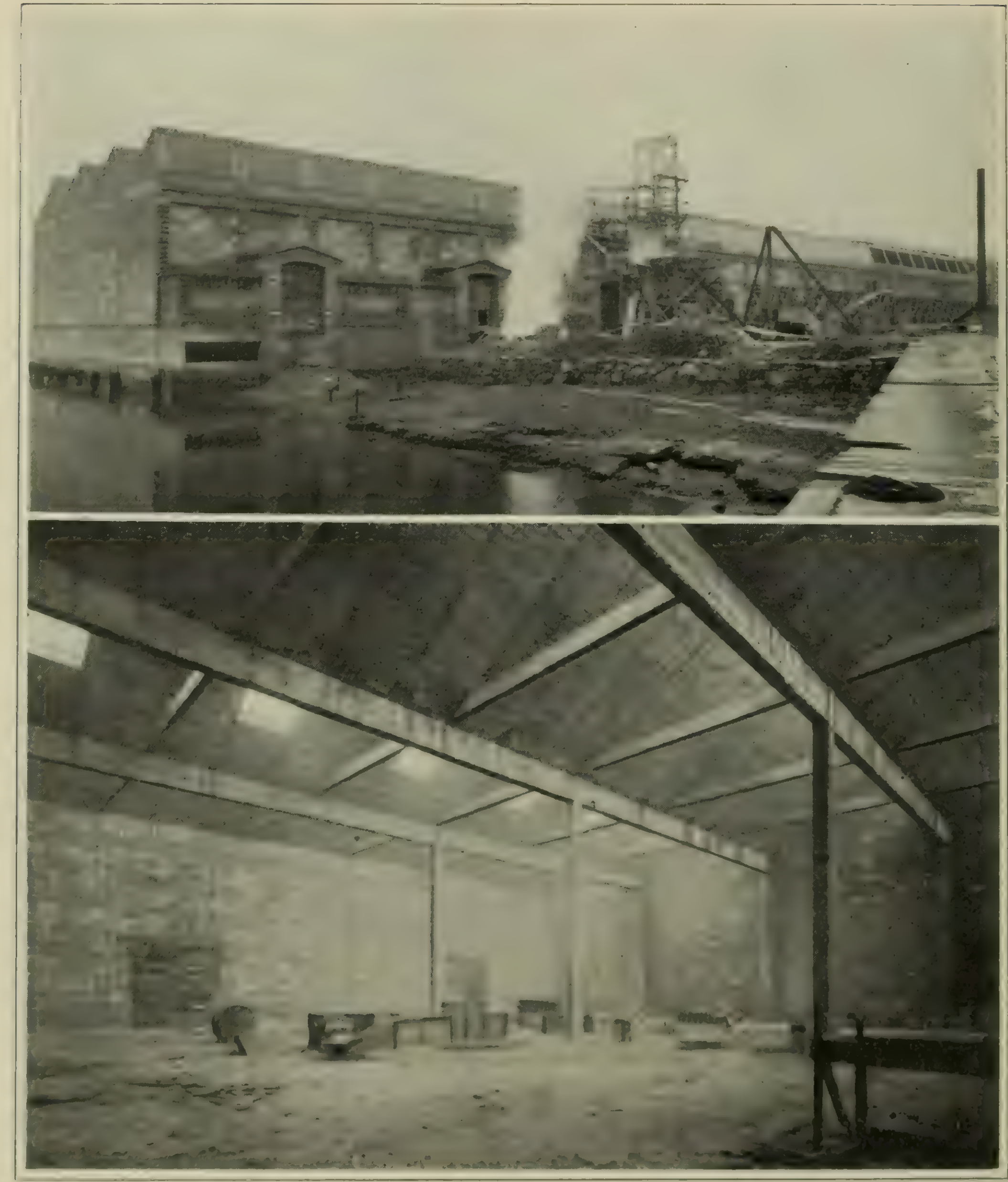
* This phase of the use of reinforced concrete is discussed further and is also illustrated in Mr. von Schon's article elsewhere in this issue (p. 353).

STORE HOUSE FØR THE WESTERN ELECTRIC CO., N. Y.
Eidlitz & McKenzie, architects. Reinforced-concrete construction by the Turner Construction Co., N. Y.

output, is of considerable value. In a few isolated and exceptional cases fireproof construction has been obtained for the same price as mill construction, but usually it will cost from 10 to 25 per cent more. A steel frame fireproofed will cost from 25 to 40 per cent more than reinforced concrete.

An advantage with this type of construction is that concrete is mixed and placed by common labor, which is the cheapest form of labor obtainable, with only a few experienced men to direct. This materially reduces the troubles with labor unions. Carpenters are plentiful and their unions are not so troublesome as those of the masons. Sand and stone are plentiful, and are to be found everywhere. Lumber suitable for forms is easily obtainable. The only materials coming from a distance are the cement and the reinforcing bars. Thus the greater part of the cost of a mill is returned to the community in which the work is done.

Concrete will carry its full load in one month. It is impossible to build so fast as to overload columns and walls. Greater speed has



EXTERIOR AND INTERIOR OF FACTORY FOR STOLLWERCK BROS., STAMFORD, CONN. Ernest Flagg, architect; W. L. Stoddart, consulting architect. Reinforced structure designed and built by Tucker & Vinton, N. Y. Monolithic bearing walls and concrete-block facing; hollow roof and walls to preserve uniform temperature. Saw-tooth roof, 50-ft. spans and 25-ft. bays.

been obtained than in any other type of construction. Examples of this are abundant. With necessary but not very expensive precautions, work can be done in mid-winter with safe ultimate results, and thus valuable time can often be saved. When a building is first completed it is weaker than it will ever be thereafter. During the process of construction, building materials are piled on the floors, often in excess of their figured loads, so that the owner can always feel assured that the building when accepted is absolutely safe. Concrete exposed to view on all sides is its own inspector; there is no half way condition—it is either good or bad. The bad cannot be hidden until after acceptance. Specialists know this and it is a better guarantee of good work than a surety bond. If by any mischance any member is loaded to the point of failure, fine cracks appear first giving due warning, the failure coming gradually. Thus serious results can easily be avoided.

Serious accidents have occurred in the past, it is true, and have been reported in the daily and technical press. The causes have been apparent and do not cast reproach on concrete as a material of construction any more than a failure of brick, wood, or steel does today.

A number of years ago an engineer made complete plans for some grain elevators. These were circular tanks. The owner let the contracts and supervised the work. In his opinion there was an excess of steel. He left out some, with the result that when the bins were filled, they burst, allowing the grain to escape.

A small highway bridge was built in Indiana, of beam construction, designed by an engineer unfamiliar with reinforced concrete and erected by a contractor without experience. When put in service, it failed under the load of a road roller. It developed that the reinforcing bars were less than one-half the necessary size and were only long enough to reach just to the edge of the supports.

In the accident at Hotel Bixby, Long Beach, Cal., which occurred November 9, 1906, it was found that the columns were insufficient in size, the steel rods in beams and girders were not long enough to reach to a proper distance over the supports, and there was lack of proper supervision in the mixing and placing of materials.

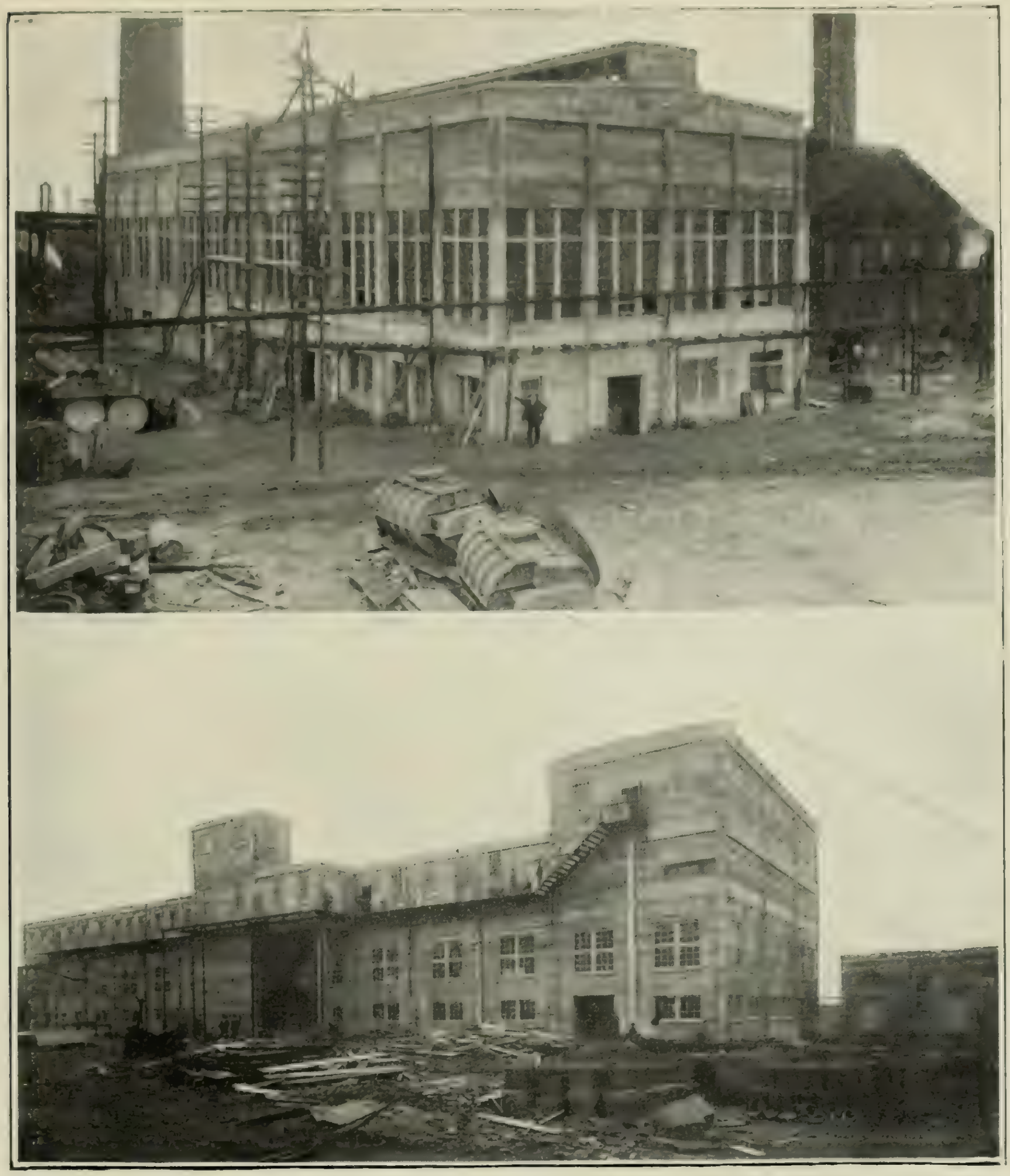
At Lawrence, Mass., the roof of a filter recently fell in. The work was put in in the autumn and froze before the cement set, alternately thawing and freezing during the winter until the centers were drawn in the spring. In this case, the concrete was injured by the weather.

These experiences should be interpreted to mean that only responsible contractors who have had experience should be permitted to figure on work, and that they should be supervised by competent inspectors. If owners would only realize it there is no greater extravagance in building work they can run into than to employ an engineer who cuts his commission, because this implies he is inexperienced, or to employ a responsible engineer for making plans only, thereby saving two or three per cent. on the cost of the job. They are likely to lose several times this in the quality of the work, with the danger of accidents which necessitate repairs or incur other expense in maintenance or operation far in excess of the saving on engineering.

There was a recent case of fire in the upper stories of an eight-story building used by a printing house. Water was thrown into the upper stories; as it could not run through the floors, it ran down the stairs. The employees in the lower stories, rather than go down the wet stairs, having perfect confidence in the safety of the building, remained in the lower stories looking out of the windows at the work of the firemen. Could this occur with any other type of construction?

As previously stated, designs can be accurately made and the results guaranteed. Nevertheless, this type of construction, more than any other, should be handled by specialists, as there are a number of details which they can care for which, if overlooked, would result in a building that might prove unsatisfactory to the owner. A few years ago a great deal was heard about systems of construction, every designer having a separate method and nearly every builder a different type of reinforcement. It has now been well established that any type of reinforcement whatsoever can be used to obtain certain results. The differences in cost between the different types of reinforcement and different methods of design are of minor consideration.

Only a few general hints will here be given regarding design. Tests on long-span beams identical in every way except that some were plain, others reinforced, proved that those which were reinforced developed twelve times the strength of the plain concrete. The principle of all designs is to use concrete in compression, and reinforcement wherever there is any chance for tension. In footings it is cheapest to use reinforcement, thus reducing the depth and saving in excavation, often avoiding trouble with water, thus making a saving in expense. Use an octagonal footing with bars running in four directions. In columns, the cheapest form of reinforcement to resist compression is cement. Mixtures as rich as one part cement to one part stone are safe for a load of 1,200 pounds per square inch. Use steel only to resist possible bending due to eccentric loads and to tie the joints between columns and floors rigidly together to resist wind pressure. In floors it is much better to use girder and beam reinforcement which is fabricated into units and tied in some way at the columns than to use a number of loose bars. A flat floor with bars running in all directions between columns can be made as strong as beam construction, and on account of the ease of building wooden forms, is often cheaper and quicker to construct than beam floors. Where desired, wooden floors can easily be laid on top of concrete and are more rigid than when laid over wooden beams. It is cheaper to construct curtain walls after the columns and floors are built, supporting these walls on top of the floor.



POWER HOUSE AND ELECTROLYTIC BUILDING FOR THE ORFORD COPPER COMPANY.
The electrolytic building is 75 by 240 by 40 feet, and contains also laboratories and offices.
Designed and constructed by the Curtin-Ruggles Co., N. Y.

There are several ways of treating exposed surfaces. The surface obtained direct from the wooden forms can never be considered a satisfactory finish for exposed exteriors. The cheapest and most durable way is to cut with sharp pointed tools 1/16 to 1/8 inch off the surface. This obliterates all marks of the wood, exposes the stone, and gives an even light gray color. A smooth surface can be obtained also by a wash coat of cement; this, however, is liable to be discolored by efflorescence or other cause and to lack uniformity. It is possible to obtain as handsome and ornamental surfaces as can be got from natural stone or terra cotta. These treatments, however, are too expensive to be considered in mill construction.

THE PURSUIT OF INVENTING AS A BUSINESS.

By George F. Stratton.

The interesting development which forms the topic of Mr. Stratton's commentary is perhaps peculiarly characteristic of the "American system" of mechanical production. At least, it belongs to the new order which has replaced the old shop full of "all-round mechanics" with the shop manned by tool tenders and officered by specialists. It may be new to some readers to know how definitely certain large concerns are setting out to answer the problem of providing, for the future, a supply of originating genius similar to that which formerly was associated with the skilful handling of tools at the bench.—The Editors.

WHENEVER the first of the human race made his first attempt to subjugate existing conditions to his will and, prompted by the opening dawn of a reasoning faculty, made the simplest combination which did not before exist, then was the first era of invention. The first robe of skins was an invention and it must have been preceded by the invention of the implement, or method, by which that skin was secured.

Invention, then, is the oldest of the Arts, the Sciences and Trades. We are told that Tubal Cain was "an instructor of every artificer in brass and iron." The invention of the processes of smelting and working those metals must have long antedated him. Yet it is only within the last quarter of a century that inventing has been practiced as a regular business. For many centuries there have been men who have devoted their lives to philosophical research and scientific discovery; but they were rarely inventors. They were rather investigators and discoverers, probing deeply into the causes of natural phenomena and, by patient and laborious study, reducing their investigations to mathematical formulæ.

During the past century, with the advent of the steam engine and the consequent wonderful development of manufacturing, great inventors have appeared. But they usually developed into great manufacturers. Watt, the inventor of the condensing engine, after ten years of exhaustive experimenting devoted himself to the commercial exploitation of his engines. Stephenson, famed for his locomotive, established shops for its manufacture as soon as he had demonstrated its practicability. McCormick, the inventor of the reaper, became a great manufacturer. Ericsson, although a persistent and prolific inventor, was also always interested in manufacturing.

In contrast to all this, the modern tendency seems to be to keep the inventor inventing by affording him fair rewards for his genius, and to place the exploitation of his inventions in the hands of trained and skillful business managers. It may be safely stated that Thomas A. Edison is the inventor of the business of inventing. He has never been anything else but a professional inventor in the most exact sense of the term. He has never been a manufacturer. Although for a short period he was in partnership with a manufacturer, his attention was never given to the commercial end of the business. He devoted himself entirely to the improvement and development of the articles which the firm was making. He invented, always, and did nothing else. The first large sum of money which came into his possession ($40,000 for the stock ticker) he immediately devoted to the equipment of a shop for experimental purposes. He installed chemical appliances and materials, and an outfit of machines and tools which would meet every requirement for putting his ideas into concrete form. In the fitting up of that shop—in the purchase of machines and tools, and the intricate and delicate experimental apparatus—not one thought was given to the adaptability of it all to the commercial manufacture of any one article. Nor has it ever been so used. As new inventions were made and their practicability demonstrated by actual working apparatus made in that shop, they have been invariably turned over to some outside or subsidiary company for commercial exploitation. Edison concerns himself no further with them, except to watch for the possibility of improvement in them. The brain which today perfects a phonograph, turns tomorrow to a storage battery. He has patented eight-hundred inventions. His average for some years has been two each month.

And yet, this inventor, who has confessed to almost total ignorance of the practices of commercial life, shows surprising ability for systematic and business-like conduct of his profession. He wastes no time upon ingenious toys. "If it can be done, is it worth anything?" is his invariable question upon first confronting a problem. If he is convinced that his ideas will conduce to the advancement of industry, or science, or art, he goes ahead—and never gives up until he has convinced himself of the practicability or impracticability of that idea. He says:—"I can't recall a single problem in my life, of any sort, that I ever started on, which I didn't solve or prove that it couldn't be solved."

The most striking instance, not only of his persistence but also of his systematic methods, is seen in the accounts of the invention of the incandescent lamp. The filament gave him the greatest trouble and, in his search for suitable material, he sent hundreds of letters to United States consuls in all parts of the world, requesting samples of bamboos, reeds, and other vegetable fibres, and he followed this up by despatching special explorers to search wild and uncivilized countries where, as Frank McGowan (one of the explorers) said, "A United States consul was usually eaten before he'd had time to open much mail." Between three thousand and four thousand samples were collected from this systematic search, and of all these only two or three were found to be of any use. But they were sufficient, and resulted in the incandescent lamp. Again, in the search for the best material for phonographic records, he sent seven men into India, China, Africa and other parts of the world for new vegetable bases for waxes. It took five years to find the right article, but then it was the right one and is in use today. Another remarkable instance of his systematic method is shown in his determination of the presence of radium in almost all substances. Upon each of seven hundred sensitive photograph plates he caused to be placed fifty different substances. The plates were then locked up in a dark room for seven weeks, and the presence of radioactivity in each of these thirty-five thousand substances was detected when the plates were developed.

All that is systematic business, and a method of doing business which would be creditable to the most determined and enterprising Captain of Industry at the head of any manufacturing plant in the world.

Leaving the Wizard of Menlo Park, we come to a large group of professional inventors who have appeared in the last quarter of a century. These comprise the experimental forces of the great industrial works. They are men engaged under salary to invent and develop improvements in the articles manufactured—to meet the demands for new articles and to devise new methods of manufacturing. They are men who come from a variety of businesses and professions. Frequently they are trained engineers or chemists. Quite as frequently they are mechanics of no knowledge of mathematics or first principles, but with wonderful mechanical ingenuity.

In the General Electric Company's works at Schenectady, N. Y. and Lynn, Mass., there are to be found, among the expert force, an ex-newspaper man, a groceryman, a fisherman, a cabinet-maker, and a one-time hack-driver. This company employs, in its various component plants, a total of thirty thousand hands and spends upwards of two and a half million dollars, annually, in making and developing inventions. It employs, in addition to the experts, a corps of twelve patent attorneys and twenty-eight assistants. The great Westinghouse Electric Company maintain almost as large and expensive a department. The Bell Telephone Company, the Hoe Printing-Press Company, the National Cash Register Company, the United Shoe Machinery Company, and scores of smaller companies, carry a force of men upon salary whose duties are to invent and to develop the best possibilities of inventions.

Then, we find another group of professional inventors—smaller in numbers and engaged upon humbler matters than the experts above mentioned. In fact, they are scarcely ever known as inventors, their ideas being seldom patented. In almost every large plant where a quantity of machinery is used, may be found one of these men. In one shop he will be known as a "tool expert." In another as an "adjuster." In yet another he will be called the "doctor." He is frequently taken from the ranks of the working mechanics. He will be seen wandering around the shops and studying the machines—no matter how large or small. The great boring mill and the smallest bench tool alike engage his attention. He secures his job, and holds it, by his unusual ingenuity in devising little things—a bolt here, to guard against some special strain; a new pulley there, to increase the speed of a certain part. He devises small attachments to enable a machine to do some special job. He sees a method of saving oil on one machine, and of facilitating the feeding of material to another. He keeps an eye on the hang of the shafting and the balance of pulleys; and he designs methods of adapting the motor-drive to belt-driven machines. If a contract for new work is undertaken he is consulted as to what machines and tools can be used, and how they may be adapted to handle the work with the greatest economy and expedition. He makes suggestions upon the drawings and patterns of new work, which frequently result in such modification as will greatly cheapen the production, without affecting the efficiency or quality. He is inventing, always; little matters, it is true, but they are recognized as being of such importance and utility that a salary of from $50 to $100 per week is by no means uncommon.

From this group of inventors have come some of the greatest of labor-saving devices. The metal and textile industries of the world especially owe much to these unassuming and comparatively unknown men. It has been stated that a great machine shop in New England has easily effected a saving of $50,000 annually by the services of one of these "doctors."

Of course, outside of these independent and salaried professional inventors is the great army of men who, while actively engaged in occupations embracing every line of human endeavor, develop new ideas, often of great value and just as often altogether out of their line of regular work. An inquiry into the personalities of a few dozen inventors, to whom patents have been granted during the past year, shows some remarkable facts. Among them, a sea-captain has patented a steering gear for automobiles, while a carriage-builder has invented a ship's capstan. A blacksmith has papers for a fishing-reel, a shoemaker, for a typewriter; a physician, for a door lock, and an undertaker, for a hoisting derrick; and many others show just as strange deviation from their regular walks of life.

These inventors are, however, sporadic. They cannot be said to be in the business of invention. Moreover, a very large proportion of such men are utterly impracticable in their ideas, although they undoubtedly show great ingenuity. Good, all-round inventors—men who make inventing their life work—are very rare, while the demand for them is increasing in a surprising degree. This demand is due, of course, to the consolidation of manufacturing industries into great central organizations with vast resources, and ever-growing eagerness for new and improved methods of manufacturing.

Aside from the salaried positions which are being offered in increasing numbers by the great corporations, is the broad opportunity for independent inventors. Given a man of bright mechanical ingenuity and, with a workshop suitably equipped with tools, his services would be greatly in demand by the smaller manufacturers, to solve mechanical problems for them. If such a man would leave the exploitation of his inventions to others, and keep ever before him the invariable maxim of Mr. Edison: "If it can be done, is it worth anything?" thus withstanding the disastrous temptations of every inventor to jump at every mechanical puzzle, for the sole reason of solving that puzzle, his services would be continually in demand, and his success assured.

EFFICIENCY IN THE BURNING OF FUEL UNDER THE STEAM BOILER.

By William D. Ennis.

I. THE INFLUENCE OF AIR SUPPLY UPON ECONOMY OF COMBUSTION.

One of the very significant things in the field of mechanical engineering just now is the wide-spread and eager movement in search of better economy in the boiler room. As Mr. Bolton put it in his series on superheated steam which was concluded in our May issue: "If steam is to retain its place as a method of power development, its whole cycle of operations must come under the definite and concentrated treatment which has been accorded in the past mainly to one end of the operation, viz., the steam-cylinder part of the combination."

Mr. Ennis's discussion which begins in this issue is therefore as timely as it is thorough. He starts on the solid ground of fact and physical law, and makes perfectly clear what conditions are necessary to the economical burning of coal under the boiler, and what steps should be taken to discover whether these conditions are secured in any given plant, or if not, what remedies should be applied. His articles, which will be continued, will prove of great value to the careful and progressive power-plant manager or owner. The next section will deal with the measurement and control of draft.—THE EDITORS.

THERE is a notable tendency in present-day steam plant practice, toward better operation of boiler furnaces. It has long been known that the average steam boiler generally operates at an efficiency seriously lower than that which may easily be reached by proper firing. To a certain extent, this has been due to the fuel. American steam-boiler practice began in the eastern United States with anthracite coal as fuel. With the gradual extension of manufacturing to the West, the available steam coal has been one containing lower percentages of carbon and higher percentages of hydrocarbon. Boiler settings and furnaces designed for anthracite, which is nearly all carbon, were found unsuitable for the highly volatile bituminous coals. In fact, tables have been published showing the relation of possible boiler efficiency to quality of coal—as if there were some physical law prohibiting the attainment of even a proportionately equal useful quantity of heat from the poorer grades of coal.

There is no such physical law. The reasons why boiler efficiencies have been, and are still, less with the Western soft coals than with Eastern anthracite, is that grates, furnaces, and settings designed for the latter fuel are entirely inapplicable to the combustion of any fuel high in volatile hydrocarbons. For some years, this fact has been pretty well established; but from inertia or some other cause, a large proportion of soft-coal burning plants continue to operate at efficiencies from one-half to three-fourths as high as they might readily obtain by proper furnace construction.

A similar low efficiency, as compared with that of good operation, is found in many plants burning hard coal. A steam boiler, as a machine, differs markedly from a steam engine. In the case of the latter, if it be once started under proper conditions of load, pressure and vacuum, the operator can do practically nothing that will affect the economy. With the boiler, every move that is made has a vital relation to the fuel efficiency. Economical engine performance is a matter of design. Economical boiler performance, while limited by design, is, within those limits, a matter of operation.

Since large boiler plants are comparatively recent, and the operation of the steam boiler has heretofore been committed to the least intelligent class of labor about the power plant, it is not surprising that the results of this operation have fallen far from the ideal, whether anthracite or soft coal has been the fuel.

At the present moment, several causes are contributing toward a correction of this condition. We have enormous power plants, in which even a small percentage of loss may represent a cost equalling the income of a millionaire. The stake here is so large that boiler operation must be given attention. The advent of the gas engine, also, has forced the steam engineer to seek the largest possible immediate gain at the fire-door and damper. Recent devices for the accurate indication and recording of flue-gas and furnace temperatures, and of intensity of draft, have facilitated investigation of these subjects in their relation to economy; and new forms of recording apparatus showing the chemical composition of flue gases have permitted close and continuous observation on this most essential subject.

The revival of interest in boiler economy has been most pronounced during about a year's time. It bears all the ear-marks of a revival not yet on the wane. It would seem probable that it marks the beginning of a general increase in boiler efficiency from 50 or 60 per cent to an average of 70 to 75 per cent. Concurrently, a marked influence is beginning to be exerted on questions of engineering involved in boiler, setting, furnace, grate, and stoker design.

The chapter of the day in this most interesting evolution might well be headed, "Draft." As will be shown, the subject matter of this chapter is rather air supply than draft; the two not being identical. Not to quarrel, however, over a matter of terminology, the essence of the subject is that, in the past, coal has been burned almost universally with an excessive amount of draft. So serious has been the loss from this excess, that it is not too much to suggest that the damper should now be regarded as the rudder wherewith the power plant must be guided—bearing the same relation to economy that the pressure gauge does to the existence, as an entity, of the power-generating equipment.

It is not necessary to break any existing records. What is necessary, is to equal existing records in actual, average daily operation. We now have recorded boiler tests showing efficiencies above 80 per cent. If we can advance from our present average of 50 or 60 per cent to this former figure, we shall have made a greater gain, and on an infinitely greater scale, than if we were to increase the 80 per cent to the 100 per cent of perfect operation. As a matter of fact, we cannot expect to increase greatly the efficiency figure of 80 per cent, even under the exceptionally favorable conditions conducive to record-breaking; much less to so improve the conditions of combustion as to surpass it under the harassments of average operation. Even if the loss to the stack were entirely overcome (which might be done theoretically, by using a series of economizers which would utilize all the heat in the gases down to the temperature of the atmosphere) we should still have to face losses due to radiation, loss of coal in ash, and power to produce draft. One of the most efficient plants in existence found that the two former losses alone amounted, on the average, to 10.4 per cent. If draft were produced naturally, and the air supply could be kept down exactly to that amount which is necessary for complete combustion, the loss to the stack with gases only 400 degrees above the temperature of the air would be $12.6 \times 400 \times .2375 = 1{,}200$ B. T. U. per pound of coal, or say 8.6 per cent. Practically, therefore, our efforts for improvement in power-plant operation may best be directed at the damper.

To simplify our investigations, we may assume that the fuel is pure carbon, developing, when completely consumed, 14,500 B. T. U. This quantity of heat is evolved when the reaction $C + O_2 = CO_2$ occurs, or when a sufficient quantity of oxygen is supplied to permit of the production of carbon-dioxide gas. If the supply of oxygen is limited, or if only a limited quantity of oxygen is so mingled with the carbon as to unite with it chemically, the carbon may unite with a lesser proportion of oxygen to form carbon monoxide; the reaction being $C + O = CO$. In the combustion of carbon under these conditions, the heat evolved per pound of carbon is 4,400 B. T. U. Consequently, a deficiency of oxygen may result in a combustion efficiency of only $4{,}400 \div 14{,}500 = 30.4$ per cent.

To consume one pound of carbon, completely, oxygen must be supplied in proportion to the relative combining weights of the two elements. The value of oxygen to carbon in carbon dioxide is 32 ÷ 12, or as 2 2/3:1. Oxygen amounting to 2 2/3 pounds must therefore be supplied for each pound of coal burned. As air contains 23 per cent by weight of oxygen, the air supplied per pound of coal must be 11.6 pounds. With this amount of air thoroughly mixed with the carbon, all of the latter will be burned to CO_2, evolving its full calorific value of 14,500 B. T. U.

If the supply of air is cut down 1 per cent, a corresponding percentage of carbon will find no oxygen for combination. Under certain circumstances this 1 per cent of carbon might be discharged at the slack, representing at least a 1 per-cent loss in heating value of the fuel. It is more likely that this carbon will rob another 1 per cent of carbon of its share of the oxygen, so that 2 per cent of carbon will be burned with a quantity of oxygen only half sufficient for complete combustion. Carbon monoxide will therefore be formed, entailing a loss of 70 per cent, which applying to 2 per cent of the fuel entails a loss of 1.4 per cent of the total heating value. Roughly speaking, therefore, a 1 per cent shortage of air supply involves a 1½ per cent loss of fuel. There is also a further loss due to the decreased temperature in the furnace and consequent slower transmission of heat to the steam.

A far more serious loss occurs in case of an excess of air supply. All the air supplied to the fuel is discharged to the stack at a temperature much higher than that at which it reached the grate. This elevation of temperature measures the loss of heat due to the air supply. For every pound of air discharged at a temperature, say 400 degrees above that of the atmosphere, there are wasted 400 × .2375 = 95 B. T. U. We have seen that at the least 11.6 pounds of air must be supplied per pound of carbon, entailing a loss (including the carbon itself) of 12.6 × 95 = 1,200 B. T. U. For every 10 per cent of air supplied in excess of the necessary 11.6 pounds there is a further loss of 110 B. T. U., say 0.75 per cent of the heat in the fuel. In ordinary practice, the excess of air is rarely under 50 per cent—a loss of 3.75 per cent in heating value—and is often 200, 300, and even 500 per cent—making the loss in the last case 37½ per cent of the total heat value paid for in the coal.

An additional loss, not permitting of such precise estimation, is due to the decreased furnace temperature. If the quantity of air supplied is just sufficient for combustion, and the specific heat of the gases be taken at .2375, the temperature in the furnace is necessarily 14,500 ÷ (12.6 × .2375) = 4,850 degrees. If twice this quantity of air be supplied, the furnace temperature will be 14,500 ÷ (24.2 × .2375) = 2525. The rapidity of transmission of heat through tubes, from furnace to water and steam in the boiler, depend upon the difference in temperature inside and outside the tubes. If the temperature inside is 300 degrees, and the gases leave the boiler setting at 500 degrees, we have the following conditions:

	Case. I.	Case II.
Air supplied per lb. of fuel	11.6 lb.	23.2 lb.
Furnace temperature	4,850 degrees	2,525 degrees
Exit temperature	500 "	500 "
Average temperature of gases	2,675 "	1,513 "
Temperature inside tubes	300 "	300 "
Average difference in temperature	2,375 "	1,213 "

It is easy to see that a very much less quantity of heat will be transmitted to the steam, in a given time, in Case II than in Case I. Some writers would say that the difference in quantity of heat transmitted would be proportional to the difference in temperature, in which case only about half as much heat would be transmitted when the air was 100 per cent in excess. The actual difference in transmission is probably not so great. Further, in Case II, the velocity of gases would be greater and the time for transmission consequently less. This would make the loss in efficiency due to excess air still greater. Another modifying factor is that the "exit temperature," or temperature of gases as they leave the boiler would probably be lower in Case II. Practically, the total quantity of heat transmitted to the boiler is kept nearly uniform for widely varying rates of air supply by decreasing the gas velocity (or in other words, by checking the draft) concurrently with decrease in air supply.

This feature of excessive air supply is not usually considered in estimating the losses due thereto. The loss by reason of the greater amount of heat delivered to the stack would seem to be sufficiently serious to induce any power-plant owner to set about reducing the excess, without this further argument.

As has been noted, a deficiency of air supply results also in a lessened furnace temperature due to the formation of carbon monoxide instead of carbon dioxide. Under certain circumstances, which will be described later, there is often at one and the same time both an excess of air and a partial formation of carbon monoxide. In this case, the temperature of the furnace may actually increase with increasing percentages of CO, up to a certain point.

Much progress has been made in reducing air excess. At an early stage of steam-boiler practice it was thought that at least 100 per cent of excess air was necessary to secure complete combustion;

the idea being that the air and gases could not be thoroughly mixed without this excess. Even quite recently, a well-known writer recommended an air supply of 19 pounds per pound of coal as conducive to highest efficiency. This would give an excess of 64 per cent. We are fortunately beginning to get still more close to perfect operation, in well managed plants, one of which is regularly operated with an air excess of not more than 30 to 40 per cent. Under such circumstances, we may soon expect to hear of furnace temperatures much higher than 3,000 degrees, which was the highest recorded at a quite recent date.

The study of air supply and its effect on combustion is made possible by suitable apparatus for the analysis of flue gases. Confining our argument to the assumed case of pure carbon, these gases contain, mainly, oxygen, nitrogen, carbon monoxide and carbon dioxide. As has been seen, the best flue gas from the standpoint of economy would be one containing carbon dioxide and nitrogen only: all of the carbon being completely consumed, without the disadvantage imposed by an excess of air supply. With an excess of air, the gas would consist of carbon dioxide, nitrogen and oxygen; with a deficient air supply, carbon monoxide would be found, without any oxygen. In actual practice, on account of the incomplete mixture of air with the gases from the fuel, it is usual to find all four constituents together—some carbon monoxide, denoting incomplete combustion, actually accompanying free oxygen; this latter being the evidence of an excess of air supply over that actually necessary for complete combustion. It is evident, therefore, that the effective mixture of the air and gases in the furnace is of fully as much importance as the mere supplying of a sufficient quantity of air. In the case of fuels high in hydrocarbon it is perhaps of the greater importance.

Disregarding the question of mixing, we may proceed to investigate the relation of flue-gas composition to combustion efficiency in the case of pure carbon. By supplying 11.6 pounds of air per pound of fuel, we produce 12.6 pounds of gas, of which 3.67 pounds is carbon dioxide, the balance being nitrogen. The percentage of carbon dioxide by weight is therefore 29.1. Flue gases are usually analyzed by volumetric methods, the constituent parts being expressed in percentages of volume. The relative specific volumes of the several gases under consideration are as follows:

Carbon dioxide	.0909
Carbon monoxide	.143
Oxygen	.125
Nitrogen	.143

A gas containing 29.1 per cent of carbon dioxide and 70.9 per cent of nitrogen, by weight, would therefore contain, by volume, about 21 per cent of the former and 70 per cent of the latter. This 21 per cent is the highest possible proportion of carbon dioxide that can be contained in flue gases resulting from the combustion of carbon in air. If more air is supplied, no greater amount of carbon dioxide can be formed; and as the total amount of gas will be greater, the proportion of carbon dioxide will be less. If less air is supplied, at least a proportionately less amount of carbon dioxide will be produced, and as the fraction representing the percentage is equally decreased in both numerator and denominator, the value of the fraction is less. This is on the assumption that the carbon is burned in air. If an atmosphere of pure oxygen could be provided for combustion, the gas might be entirely carbon dioxide. There has recently been placed on the market a so-called fuel-saving device which is alleged to supply pure oxygen for combustion, air being excluded; but as the atmosphere of pure oxygen is to be provided by the mixture of 2½ pounds of powder (composition not stated) and 40 pounds of water, per ton of coal, some new and remarkable chemical reaction must be necessary to develop the 5,340 pounds of oxygen necessary to consume one ton of fuel.

When an excess of air is supplied, if the number of pounds of air per pound of fuel be x, the total gas produced will be $x + 1$, pounds. The oxygen used for combustion will be 2.67 pounds, the weight of carbon dioxide produced will be 3.67 pounds, the weight of excess oxygen will be $.23x - 2.67$, the weight of nitrogen $.77x$. From these values, we may calculate the percentage, by weight and by volume, of carbon dioxide, oxygen, and nitrogen in any flue gas, in relation to the amount of air supplied. The relation of these percentages by volume is shown by the chart, Figure 1, on page 421, the values being given in Table 1 on page 420.

Suppose, now, that there is a shortage of air supply. As has already been shown, for each 1 per cent of air shortage, 2 per cent of the carbon will be burned to carbon monoxide instead of carbon dioxide. Let x be the number of pounds of air supplied, this being less than 11.6 pounds, the quantity necessary for complete combustion. The shortage of air, in pounds, is $11.6 - x$; or in per cent, $(11.6 - x) \div 11.6$. The percentage of carbon burned to carbon monoxide will be twice this, or $(11.6 - x) \div 5.8$. Reducing percentages by weight to percentages by volume, as in Table I, we may add to the chart a curve representing percentages of carbon monoxide. The maximum proportion of this substance in the total product of

I. Air supply, per cent. of theoretical.	II. Air supply, lb.	III. Weight of flue gases, lb.	IV. CO_2, lb.	V. CO, lb.	VI. O, lb.	VII. N, lb.	VIII. CO_2, by vol. Total.	VIII. CO_2, by vol. Per cent.	IX. CO by vol. Total.	IX. CO by vol. Per cent.	X. O by vol. Total.	X. O by vol. Per cent.	XI. N by vol. Total.	XI. N by vol. Per cent.
0	0	0	....	....	....	....	....	....	....	....	....	....	....	...
10	1.10	2.10	....	.47	....	.9	....	....	.067	35.0	....	....	.128	66.
20	2.32	3.32	....	.93	....	1.8	....	....	.133	34.0	....	....	.257	66.
30	3.48	4.48	....	1.40	....	2.7	....	....	.200	33.6	....	....	.385	65.
40	4.64	5.64	....	1.86	....	3.6	....	....	.266	34.1	....	....	.514	66.
50	5.80	6.80	....	2.33	....	4.5	....	....	.333	34.2	....	....	.642	66.
60	6.96	7.96	.73	1.86	....	5.4	.066	5.9	.266	24.0	....	....	.771	69.
70	8.12	9.12	1.47	1.40	....	6.2	.134	11.0	.200	16.4	....	....	.886	73.
80	9.28	10.28	2.20	.93	....	7.1	.200	14.8	.133	9.9	....	....	1.02	75.
90	10.44	11.44	2.94	.47	....	8.0	.267	18.0	.067	4.5	....	....	1.14	77.
100	11.60	12.6	3.67	....	....	8.9	.333	20.7	....	....	....	....	1.27	79.
110	12.8	13.8	3.67	....	.3	9.9	.333	18.7	....	....	.0375	2.1	1.41	79.
120	13.9	14.9	3.67	....	.5	10.7	.333	17.4	....	....	.0625	3.2	1.53	79.
140	16.2	17.2	3.67	....	1.1	12.5	.333	14.8	....	....	.1375	6.1	1.78	79.
160	18.6	19.6	3.67	....	1.6	14.3	.333	12.9	....	....	.200	7.8	2.05	79.
200	23.2	24.2	3.67	....	2.7	17.9	.333	10.3	....	....	.338	10.5	2.55	79.
250	29.0	30.0	3.67	....	4.	22.3	.333	8.3	....	....	.500	12.4	3.19	79.
300	34.9	35.9	3.67	....	5.3	26.9	.333	6.9	....	....	.663	13.7	3.84	79.
400	46.4	47.4	3.67	....	8.0	35.7	.333	5.2	....	....	1.00	15.5	5.10	79.
500	58.0	59.0	3.67	....	10.6	44.6	.333	4.1	....	....	1.33	16.5	6.37	79.
600	69.6	70.6	3.67	....	13.3	53.6	.333	3.4	....	....	1.66	17.2	7.66	79.

Col. II = Col. I × 11.6 ÷ 100.
Col. III = Col. II + 1.
Col. VI, for Col. I = 100 or over = .23 × Col. II − 2.67.
Col. VII = .77 × Col. II.

NOTE: For percentages of air supply below 50, volumes of CO and N are given in percentages of volume of clean gases, not including free C. Computations by 10-inch slide rule.

TABLE I. FLUE-GAS ANALYSIS—PERFECT MIXTURE.

combustion is found when 5.8 pounds of air are supplied per pound of fuel, giving 6.8 pounds total gas, 2.33 pounds carbon monoxide, or 34.3 per cent by weight. If the air supply be less, proportionately less monoxide is formed: if greater, carbon dioxide is produced.

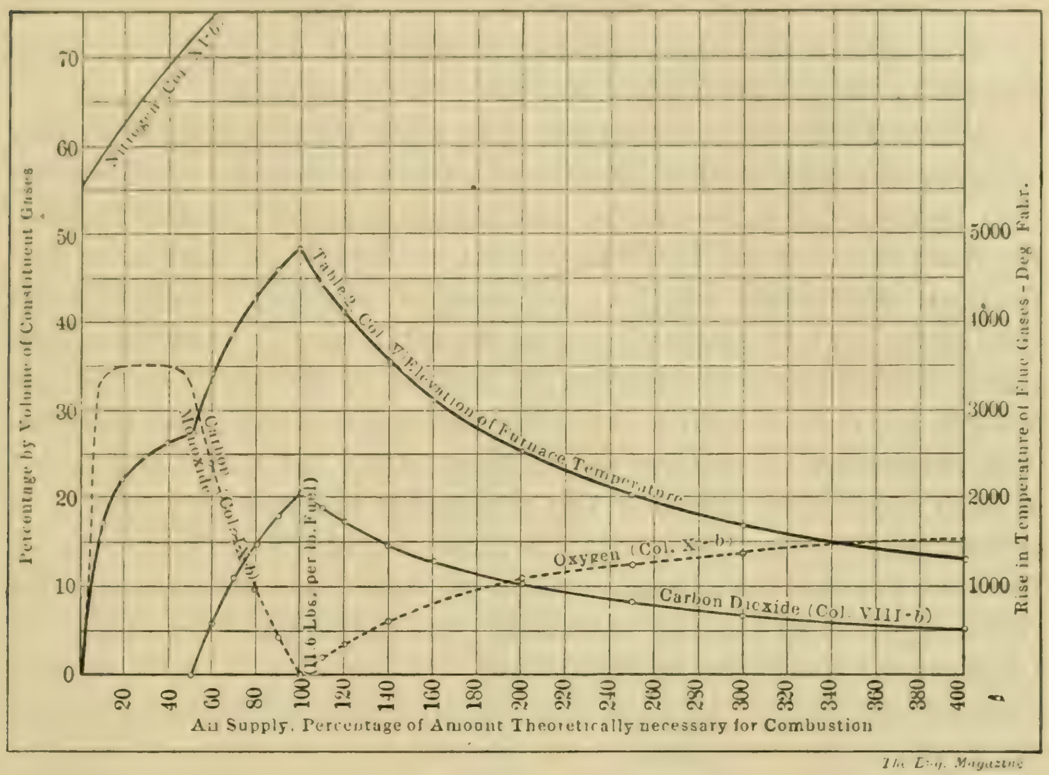


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CHART V. FLUE GAS COMPOSITION FOR CARBON BURNED IN AIR WITH PERFECT MIXTURE OF GASES.

It is evident, from a survey of this chart, that certain fixed relations exist between the proportions of the various constituent gases. The percentages of CO, CO_2 and N begin at zero for zero air supply; the first increases to a maximum at 50 per cent and then decreases to zero at 100 per cent, at which point CO_2 is at maximum and free O begins to appear. After passing beyond 100 per cent CO_2 decreases while O increases, *ad infinitum,* and N remains practically constant at 79 per çent under all usual conditions. These relations are, however, strongly modified by the incomplete mixture of the gases.

One relation that is of especial value in checking the results of actual analysis is that between excess oxygen and carbon dioxide. We have seen that where air was supplied in excess, the total weight of gas being x + 1 pounds, the oxygen amounted to .23x — 2.67 pounds and the CO_2 to 3.67 pounds. The sum of the two is therefore .23x + 1 pounds, which for high values of x bears a practically constant ratio to the total weight of gas. If we take the percentages by volume instead of by weight, we have the following:

Gas.	Weight in lb.	Relative volume.	Actual volume.	Percentage volume.
Oxygen	.23x — 2.67	.125	.0287x — .333	sum =
Carbon dioxide	3.67	.0909	.333	20.7 per cent.
Nitrogen	.77x	.143	.11x	
Total	x + 1.00		.1387x	

This shows that the combined volumes of oxygen and carbon dioxide in the gas are always 20.7 per cent of the total.

Under the conditions assumed, if we know the percentage of either oxygen, nitrogen, carbon dioxide or carbon monoxide, we have the data necessary to show whether combustion is perfect; at which point, the chart shows there should be present no oxygen, no monoxide, 20.7 per cent of dioxide and 79.3 per cent of nitrogen. Under actual conditions, perfect combustion is never obtained. To determine how nearly such perfect combustion is attained is the work of the gas analyst. No method for the direct determination of nitrogen is known. The percentage of oxygen would seem to tell the whole story; but at high combustion efficiency this percentage becomes very low. The percentage of monoxide or dioxide alone would tell nothing, because for each possible percentage of each of these there are two possible percentages of air supply. Ordinarily, the dioxide and the monoxide (or oxygen) must both be determined. If dioxide is 15 per cent, and monoxide is present, we know that the air supply is deficient and that the lower of the two possible air percentages (80 and 140) is indicated: but if the monoxide is absent, or oxygen is found, then the higher of the two percentages of air is present. In a large majority of the cases, the air supply is excessive. Having once ascertained this to be the case, the analysis of the gases for carbon dioxide answers every purpose in indicating the efficiency of combustion.

There is another reason why the determination of carbon dioxide is regarded as the crux of the situation. The phenomenon of incomplete mixing results in the simultaneous production, in a single furnace, of oxygen and carbon monoxide. These concurrent products make it impossible to calculate with any degree of exactness just what the economy may be from determination of either of these constituents: but regardless of stratification and short-circuiting of gases, if a fair sample of the average is secured, the percentage of dioxide is a certain index of economy. We know that every increase in this percentage must necessarily conduce to higher efficiency. There can be no doubt that of two furnaces, the one producing the higher proportion of CO_2 in the flue gases is the more economical.

Besides the relative proportions of the gases, Chart I shows the theoretical elevation of temperature due to various percentages of air utilized in combustion. If we assume the specific heat of the gases at ,2375, then if $x =$ the number of pounds of air supplied per pound of fuel, $x + 1 =$ weight of products of combustion, and the heat absorbed by these products per degree of temperature elevation is $.2375\ (x + 1)$, and if $H =$ total heat of combustion, as burned, of one pound of the fuel, the elevation in temperature is $H \div .2375\ (x + 1)$. For 11.6 pounds of air or more per pound of fuel, this becomes $14{,}500 \div .2375\ (x + 1)$, for perfect mixture. The computation of temperatures for various air supplies is given in Table 2, the results being shown on Chart 1.

I. Air supply, per cent. of theoretical.	II. Total wt. of flue gases, lb.	III. B. T. U. absorbed by gas per 1 degree rise in temperature.	IV. Heat generated by combustion of 1 lb. carbon.	V. Rise in temperature of gases, deg. F.
0	0	0	0	0
10	2.16	.512	880	1,720
20	3.32	.79	1,760	2,230
30	4.48	1.06	2,640	2,490
40	5.64	1.34	3,520	2,630
50	6.80	1.62	4,400	2,710
60	7.96	1.89	6,420	3,410
70	9.12	2.17	8,440	3,890
80	10.28	2.44	10,460	4,290
90	11.44	2.72	12,480	4,590
100	12.6	3.00	14,500	4,830
110	13.8	3.28	14,500	4,420
120	14.9	3.53	14,500	4,120
140	17.2	4.09	14,500	3,550
160	19.6	4.66	14,500	3,120
200	24.2	5.74	14,500	2,525
250	30.0	7.12	14,500	2,040
300	35.9	8.55	14,500	1,700
400	47.4	11.25	14,500	1,290

Col. III = Col. II × .2375.
Col. IV = (Coal burned to CO × 4,400) + (Coal burned to CO_2 × 14,500).
Col. V = Col. IV ÷ Col. III.
Computed with 10-inch slide rule.

TABLE 2. FURNACE TEMPERATURES, PERFECT MIXTURE.

CONTROLLABLE LOSSES OF HEAT AS INDICATED BY FLUE GAS ANALYSIS.

Since a definite relation exists between the percentage of carbon dioxide in flue gas and the amount of air supplied for combustion, it is easy to calculate the losses corresponding to various stated proportions of the former. We have seen that the heat lost per pound of gas is $.2375\ (t^1 - t^0)$, if t^1 be the temperature of flue gases and t^0 the temperature of air supply. For 11.6 pounds per pound of carbon, the air supply theoretically necessary, the loss in B. T. U. per pound of fuel is $12.6 \times .2375\ (t^1 - t^0) = 3.00\ (t^1 - t^0)$. For any other quantity of air supplied, say x pounds, the loss in B. T. U. $(x + 1)$ $.2375\ (t^1 - t^0)$. Dividing this by 145, we have the loss in percentage of the total heat in the fuel. These calculations are given in detail in Table 3, the corresponding relations being shown on Chart 2.

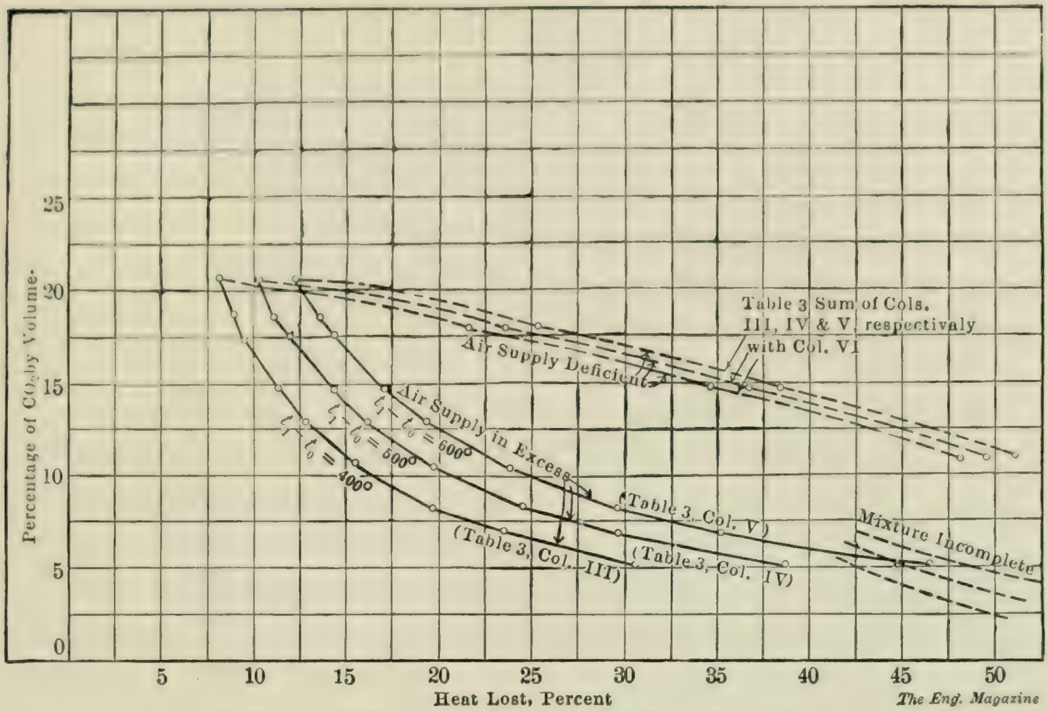
	I.	II.	III.	IV.	V.	VI.
Air supply, per cent. of theoretical.	Weight of products of combustion, lb.	Percentage of CO_2 by volume.	Percentage loss to stack for (t′-t°) as below.			·Percentage loss due to incomplete combustion.
			400°	500°	600°	
0	0	...	...	...	...	100
10	2.16	...	1.4	1.8	2.1	94
20	3.32	...	2.2	2.7	3.2	88
30	4.48	...	2.9	3.7	4.4	82
40	5.64	...	3.7	4.6	5.5	76
50	6.80	...	4.5	5.6	6.8	70
60	7.96	5.9	5.2	6.5	7.8	56
70	9.12	11.0	5.9	7.4	8.9	42
80	10.28	14.8	6.7	8.4	10.1	28
90	11.44	18.0	7.5	9.4	11.2	14
100	12.6	20.7	8.2	10.3	12.4	0
110	13.8	18.7	9.0	11.3	13.5	0
120	14.9	17.4	9.7	12.2	14.6	0
140	17.2	14.8	11.3	14.1	16.9	0
160	19.6	12.9	12.8	16.0	19.3	0
200	24.2	10.3	15.8	19.8	23.8	0
250	30.0	8.3	19.6	24.5	29.5	0
300	35.9	6.9	23.5	29.4	35.1	0
400	47.4	5.2	31.0	38.8	46.5	0

Col. I from Col. III, Table 1.
Col. II from Col. VIIIb, Table 1.
Cols. III, IV, V = Col. I × .2375 × $(t^1 - t^0) \div 14{,}500$.
Col. VI = (14,500 — Col. IV, Table 2) ÷ 14,500.
Computations by 10-inch slide rule.

TABLE 3. COMBUSTION LOSSES AND CO_2 PERCENTAGES, PERFECT MIXTURE.

Where there is a deficiency of air supply, the production of carbon monoxide, evolving 4,400 B. T. U. instead of 14,500 B. T. U., results in a loss of 69.6 per cent. The proportion of carbon which burns to monoxide being twice the air deficiency, we have for any stated deficient percentage of air, p, a loss of heat which may be expressed by $2p \times .696$. When, however, the air supply is below 50 per cent of the theoretical, only a portion of the carbon can be burned, even to monoxide, and from zero to 50 per-cent air supply the proportion of carbon thus burned rises by increments in accordance with the augmentation of air supply. The proportion of monoxide was thus calculated in Table 1, the total heat generated per pound of carbon being given in Column IV, Table 2. The loss of heat, below the full calorific value of 14,500 B. T. U., and the corresponding percentages of CO_2, when combined with the loss of heat to the flue gases, give the dotted curves of Chart II, showing that identical percentages of CO_2 indicate greater heat loss when monoxide is present than when it is not present.

It will be noted that equal increments in percentage of dioxide represent much wider differences in economy at the lower ranges of



The Eng. Magazine

CHART II. LOSS OF HEAT AS INDICATED BY PERCENTAGE OF CO_2 IN FLUE GASES.

Showing relations corresponding with percentages in the table opposite.

efficiency than at the higher. The rise from 3 to 6 per cent of carbon dioxide represents a difference in fuel consumption of about 23 per cent, while as between 15 and 18 per cent of dioxide the difference in fuel consumption is only about 2 per cent. The extreme significance of even very slight variations in percentages of dioxide, when that percentage is low, is evident. No possible measurement that can be made at any point of power-plant operation can give such startling results as this. To make the impression still stronger, it should be remembered that the loss increases, directly with the percentage of air; while the percentage of dioxide in the gases—a maximum at about 20 per cent with the theoretical amount of air—is halved every time the air supply is doubled. At maximum dioxide and minimum air the loss of heat to the stack is about 10 per cent. If the dioxide is halved, the loss is 20 per cent; if dioxide falls to 5 per cent, the loss is 40 per cent; for 2½ per cent of dioxide the loss is 80 per cent.

These approximate figures will appeal to the coal buyer, particularly in view of the fact that as low as 2½ per cent of dioxide is not infrequently found. It is not a difficult matter, with proper facilities, to reach 10 per cent of dioxide, corresponding to a heat loss of 20 per cent. If we assume that such a loss represents proper operation, then in plants obtaining lower percentages, the following amounts of fuel are being wasted:

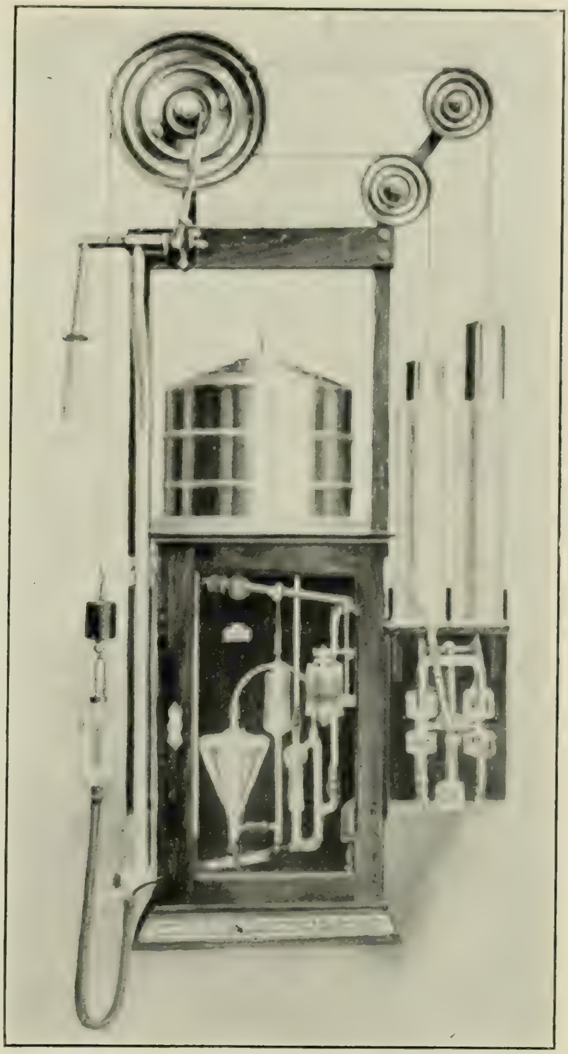
Per cent. of CO_2.	$(t' - t^\circ = 500^\circ)$ Percentage of fuel wasted as compared with 10 per cent. CO_2.
9	2½
8	5
7	8¾
6	13½
5	19½
4	29
3	45

In general, we may express these figures approximately by the formula $200 \div p = P$, in which p = percentage of dioxide in the flue gases, P = percentage of total heat lost to the stack. The calculations on which these figures are based involve several assumptions, which will be discussed later. These assumptions do not, however, modify the figures above given to any such extent as to invalidate their general relation or diminish their suggestiveness. It cannot be too strongly impressed upon the power-plant owner that CO_2 is the factor upon which depends his very existence under any circumstances of real competition.

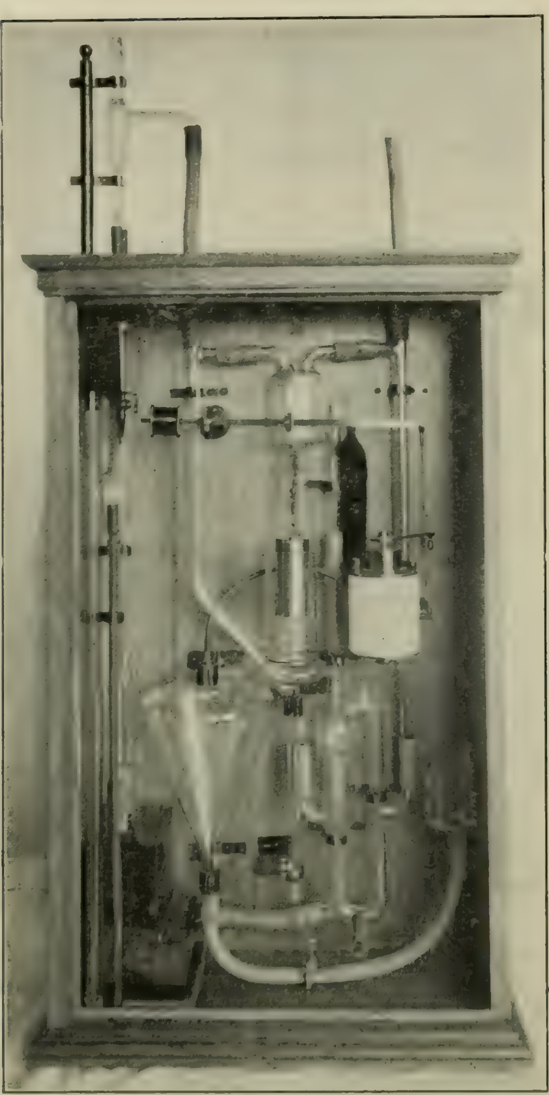
Remarkable boiler and furnace efficiencies have been obtained in the Western States by plants using California oil as fuel. This is the more noteworthy because the coal and wood-burning power plants of the same region have been rather noted for operation quite the reverse of economical. The reason for the improvement, with oil, is that oil fuel presents peculiar opportunities not only for economical general operation, but particularly for economical control of air supply and consequent high percentages of dioxide. The oil can be regularly and easily measured at slight expense; its quality is almost exactly uniform; its combustion can be regulated with great nicety, and the conditions of combustion kept constant. There is no opening fire-doors every two or three minutes; no cleaning of fires and consequent cooling of furnaces accompanied by a large influx of cold air; no damage to grate bars and brickwork resulting in a necessity for unfavorable operation until the regular shut down. One of the first steps taken when coal or wood furnaces were altered for oil fuel was to brick over the greater part of the grate, cutting down the air space to a small fraction of what it had formerly been. In addition to this, the ash-pit doors were kept nearly closed and the dampers given much closer attention. The result has been not only a large increase in boiler efficiency, but a general increase in boiler capacity of 30 or 40 per cent, due to the higher temperature of furnace maintained.

Premising therefore, the absolute necessity of close observation of air supply by means of gas analysis, it is obvious that methods of quickly, accurately and continuously indicating and recording the composition of flue gases, or at least the percentage of carbon dioxide, are of the highest importance.

Various forms of apparatus have been devised to facilitate this work. The Orsat and Hempel equipments have been used with good results for a number of years. They are accurate, but are suitable for experimental work only, giving the composition of a single sample of gas after a sequence of operations which involve a considerable amount of time. In default of anything better, they will answer. Where so large an opportunity for loss exists, the cost of manipulating the apparatus cannot be considered.


SARCO AUTOMATIC CO_2 RECORDER.
Courtesy, Sanders, Rehders & Co., London.

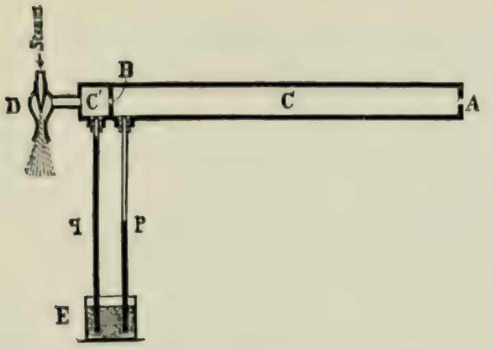
Within the last few years, in view of the urgency of the subject, there have been introduced at least three types of apparatus which more or less automatically and continuously determine the percentage of carbon dioxide in flue gases. One of the best known of these is Arndt's Econometer. This instrument consists essentially of a delicate chemical balance which is connected so as to trap and accurately weigh a known volume of the flue gases. As carbon dioxide is much heavier than oxygen, nitrogen, or the monoxide, the weight of the sample is an index to the amount of dioxide in the sample, and a graduated scale is provided along which a pointer moves, giving percentage readings direct. The instrument does not record its readings. It is inaccurate to a small degree on account of the difference in density of oxygen and nitrogen or carbon monoxide; but as the percentage of oxygen under good operation is very low, the inaccuracy does not greatly affect the results.



ANALYZING AND RECORDING PORTION OF THE SARCO APPARATUS.

Sarco Fuel Saving & Engineering Co., New York.

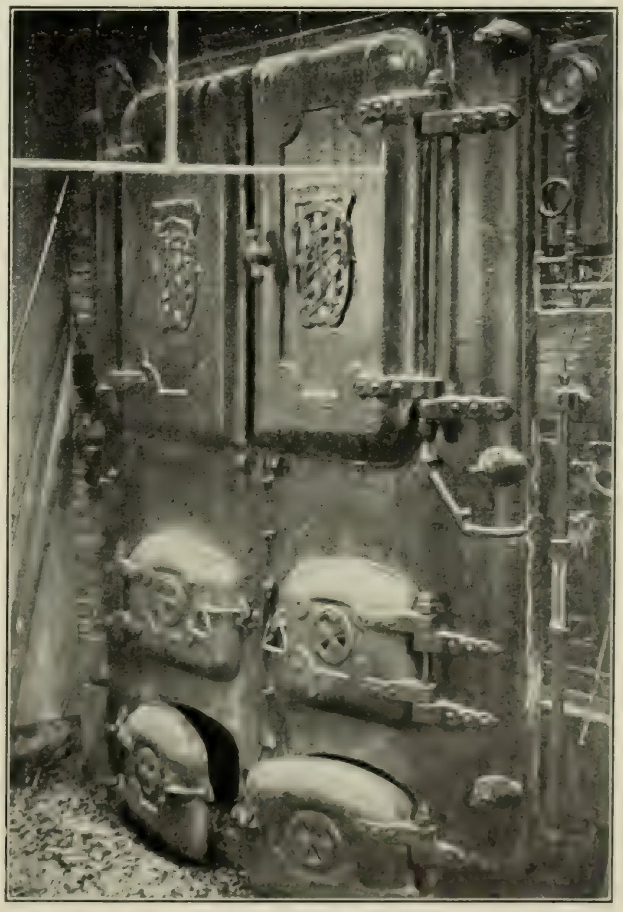
The "Sarco" Automatic CO_2 Recorder is illustrated herewith. The large cylinder at the back of the cabinet (page 427) is the "motor" or operating device, actuated by means of draft from the chimney. This cylinder (of sheet brass) is an inverted bell, floating in a tank of water. The tank has an internal cylinder rising from the bottom to a point above the water level, into which a tube enters from the flue. The suction in the flue produces a vacuum over the water and under the bell, causing the latter to descend. When it has reached the lowest point of its stroke, a valve is automatically opened admitting air under the bell, which consequently rises until the valve is automatically closed at the top of the stroke and the suction from the flue once more causes the bell to descend. The slow reciprocating motion thus obtained is utilized to operate the two pumps shown at the right of the cabinet, which suck the gases from a point in the flue near the damper and deliver them to the registering apparatus inside the cabinet. This registering apparatus is arranged to trap a fixed volume of gas at a constant pressure, which trapped portion of the gases is then brought into contact with a 27 degree solution of caustic potash. The potash absorbs any carbon dioxide present, and the remaining gas passes under a small bell which operates a counterbalanced pen tracing a line on a chart operated by clockwork. The pen is so adjusted that when no dioxide is present, the stated volume of gas will cause it to rise to the zero point of the chart. If dioxide is present, its absorption by the potash results in a decreased volume of gas, and the pen does not rise so high, the least rise occurring for the highest percentage of dioxide.



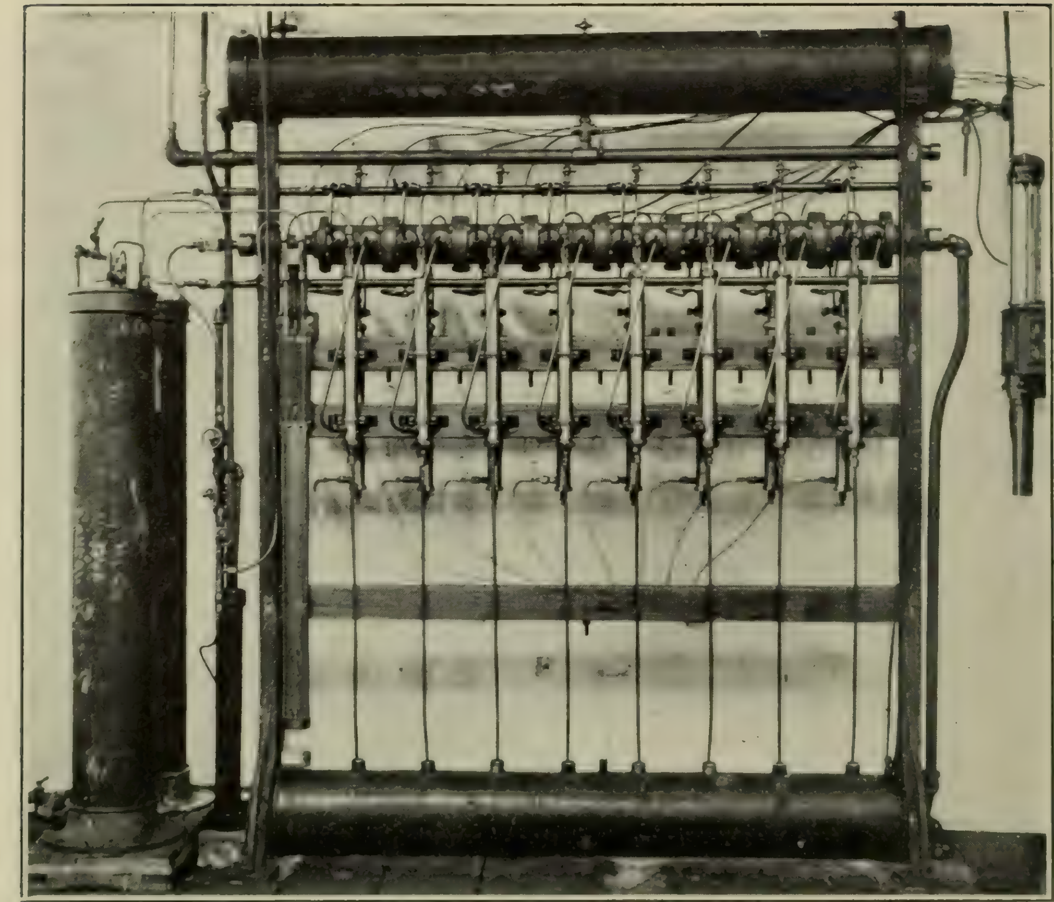
SHOWING OPERATING PRINCIPLE OF THE UEHLING GAS COMPOSIMETER.

This apparatus requires some attention, as variations in the temperature of the potash, etc., introduce irregularities; but under proper supervision it gives reliable results, which may easily be confirmed by devices furnished with the instrument, or by independent analysis. One analysis of the gas is made at each revolution of the "motor" or operating bell; and as the absorption of dioxide by the potash is a process involving some time, the operation should not be faster than one revolution in every ten or fifteen minutes. This, of course, gives an intermittent record, only: and the instrument "indicates" the results only at that instant when the cycle of operation is completed; or say once every ten or fifteen minutes.

The Uehling Gas-Composimeter is based on the law governing the flow of gas through small apertures. In the diagram on this page if a vacuum be produced in C, air (or gas) will flow from C through the aperture B, and the vacuum thus produced in C will produce a flow through A. If the apertures B and A are of the same size, the vacuum in C will be about half that in C′, so long as the same volume of gas is flowing through B as through A. If, however, a constituent of the gas be continuously removed therefrom, while it is passing through chamber C, the vacuum in that chamber will be correspondingly increased. The increase of vacuum in C



INDICATING GAUGE OF UEHLING COMPOSIMETER INSTALLED IN FIRE ROOM.



UEHLING GAS COMPOSIMETER, MULTIPLE FORM.

Can be installed thus up to 12 units in one system. Uehling Instrument Co., Passaic, N. J.

as shown by a manometer therefore indicates the volume of gas absorbed. In the instrument which has been developed by the Uehling Instrument Company, it is attempted to produce, as nearly as possible, the conditions necessary to preserve the correctness of these indications. The operation is absolutely continuous and the instrument at all times indicates the percentage of dioxide in the gas passing through it, in addition to furnishing a continuous chart showing the variations. The indicating device can be installed, if desired, at a considerable distance from the rest of the apparatus. This is an advantage, as it permits of providing an indicating gauge where the fireman can see it. Excepting the recorder, this apparatus has no moving parts. All these flue-gas analyzing devices are rather expensive and somewhat delicate, and with all of them the methods of sampling the gases are of the first importance; but, as has already been said, the stake is so large that no steam producer can afford to hesitate at the expense or the complication necessary to secure proper combustion.

THE DESIGN OF MODERN PRODUCERS AND GAS ENGINES.

By R. E. Mathot.

The constantly rising pressure of competition from the gas engine is admitted on all sides to be the greatest influence now operating to urge makers of steam machinery on to further betterments in efficiency and economy. Mr. Mathot is known internationally as a leading expert in all matters pertaining to the construction and installation of internal-combustion motors. He presents some of the latest important data and studies in this field, as Mr. von Schon and Mr. Ennis, elsewhere in this same issue, do in the case of the steam plant and the hydro-electric installation, respectively. A following article, next month, will deal with the latest principles of gas-producer design.—THE EDITORS.

SINCE the large gas engine has attained its present enviable position in industrial operation, the rules governing the construction of the internal-combustion engine seem to have undergone considerable change. From the practical knowledge acquired in constructing large steam engines, the makers of the former type of prime mover have derived valuable suggestions; in fact, a great many of the largest fuel-gas engines, such as those using coke-oven and blast-furnace gas, are turned out of shops which were formerly devoted, almost entirely, to the construction of large steam engines.

So far as general principles are concerned, it must be realized that there is no reason whatever why the substitution of an explosive mixture for steam should cause any material difference in the construction of prime movers. In both cases, we must secure perfect steadiness in the engines and we must also protect them against ruptures of the important parts liable to uneven expansion caused by high temperatures. Steadiness is obtained by the use of heavy and bulky frames which constitute large metallic seats, so shaped that they can be strongly bound to the masonry of the foundations. The use of superheated steam at a temperature as high as 350 degrees C., has enabled engineers to discover the weak points in the design of large engines with regard to expansion. Owing to their great length, tandem steam engines have afforded many valuable suggestions in gas-engine design. In the latter, the tandem arrangement is even more suitable than it is in steam-engine construction, since it affords the realization of a greater cyclic regularity than is possible in single-cylinder engines. It is, moreover, a necessary condition for the attainment of high powers like 700 to 1,000 horse power, which are rarely surpassed nowadays with a double-acting single cylinder.

The application of the principle of the double-acting cylinder to internal-combustion motors has led to the use of piston rods, crossheads, and guides, and this has given rise to the difficulties encountered with large, tight stuffing-boxes with which steam engineers have already had long experience. As a consequence of the adoption of the system of admission and exhaust by means of valves at the ends of the cylinder, as in the steam engine, the admission valves have been located at the top, and the exhaust valves at the bottom of the cylinder, the latter also acting as natural drains for the waste oils. The new systems of governing by varying the quantity of explosive mixture admitted to the cylinder, have led to the use of powerful governors protected against the prejudicial reactions on the part of mechanical devices interfering with the governing. The necessity of even and thorough lubrication of large and heavily loaded rubbing surfaces, even at the high temperatures attained in superheated-steam cylinders, brought before engineers a problem which has been solved successfully by the forced oiling and recuperation system, a device which has been successfully applied to large gas engines also. In short, it is evident that the principles involved in a great many features of the construction of large, superheated-steam engines, can be applied, to advantage, to gas-engine design.

Besides the technical principles, there are, of course, some commercial requirements that must not be overlooked. A consideration of the keen competition existing among makers of small gas engines, which has forced the cost of these motors to the lowest possible point, will show the importance of the commercial aspect of the question. Therefore, I shall endeavor to point out the limits of power within which one or another of the several arrangements, hereinafter described, ought to be applied, according to my experience and the shop rules of the leading firms with which I am connected.

It must be borne in mind that, whatever the power of the engine is to be, the gas motor must be designed to compete with the steam engine, and must be able to last, like the latter, for at least eight or ten years without requiring monthly repairs. One of the unfortunate features of ordinary gas engines of the stationary type, is the fact that many of these motors require monthly repairs after the first two or three years of use. Notwithstanding the amount that has been written on the subject by people more or less interested in the gas-engine and producer, who are, owing to that very fact, perhaps a little too enthusiastically in favor of that type of prime mover, it must be confessed that safety in working, facility of control, and cheapness of upkeep, are, so far, much better realized in the steam engine than in the modern gas engine. This is not surprising if one considers the very long history which the steam engine has behind it in comparison with that of the gas-engine. In spite of youth, however, the gas engine has made remarkable progress and it may be stated that the attainment, in the gas engine, of the working conditions of its old rival, will place the former in a position much nearer perfection than the latter, notwithstanding the claims to the contrary of makers of the steam engine.

Considering the gas engine in itself, regardless of the origin, or system of production, of the gas with which it is fed, it is obvious that the failures in working are due mainly to faulty design or defective mechanical appliances. I shall, therefore, endeavour to indicate some of the main rules and principles of construction that are now generally applied after successful use.

Ignition.—Ignition should be obtained by electro-magnetic apparatus exclusively, for engines above 20 horse power, as well as for any engine below this power if fed with producer gas. The electro-magnetic gear should be provided with a contrivance allowing the regulation of the point of ignition during the working of the engine. This should consist of a mechanical device with rods or spindles, as light as possible in order to afford a quick and sharp "break and make" not affected by the inertia due to an excessive weight or bulk of moving parts. The plug carrying the contacts must admit of being easily dismantled for the removal of any working part near it. For one-cylinder engines of more than 100 horse power, two separate and independent ignition devices, each having a magneto, should be used.

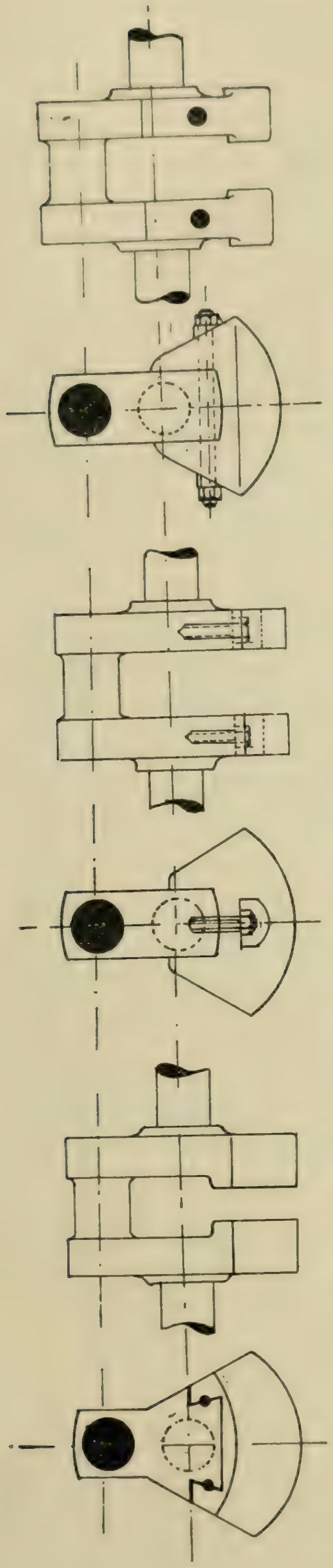


FIG. 1, 2 AND 3. METHODS OF ADJUSTING COUNTERWEIGHTS TO CRANK-SHAFT WEBS.

Crank-Shaft.—The crank shaft should be made of the best quality of mild steel. The webs should be machined out of plain metal. Counterweights should be firmly adjusted to the webs for any size of engine above 15 horse power (Figures 1, 2 and 3). During working, no kind of side movement should be allowed in the flywheels as a consequence of the flexion of the crankshaft at the time of explosion, and not even under pre-ignition. The shaft, at the journals, should be provided with a projecting ring, machined in the metal and acting as oil catcher, in order to avoid the withdrawal of oil on the flywheels, pulleys, or crank-shaft webs (Figure 4).

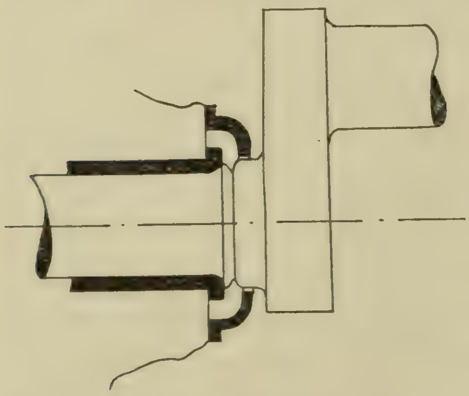


FIG. 4. OIL RING FOR SHAFT JOURNAL.

Air Suction.—This can be effected by means of air-ports, either independent or in the frame of the engine itself, though for town-gas engines the first contrivance is to be preferred. The number, shape and sections of the air passages should be designed to avoid abnormal noise or whistling. The air pipe should be provided with a valve or throttle for regulating the air supply, located close to the inlet.

Bed Frame.—This should be provided with a groove at the bottom for collecting the waste lubricating oil (Figure 5). It is preferable that the frame should be so designed that the foundation bolts pass right through the casting to secure a more rigid attachment to the masonry. The cylinder jacket should be cast in one piece with the frame and after such a design as to afford the least possible overhang.

Cams and Rollers.—These should be made of cast iron, or of the best, hard-quality steel. They should be case-hardened 1/16-inch deep and mechanically rectified.

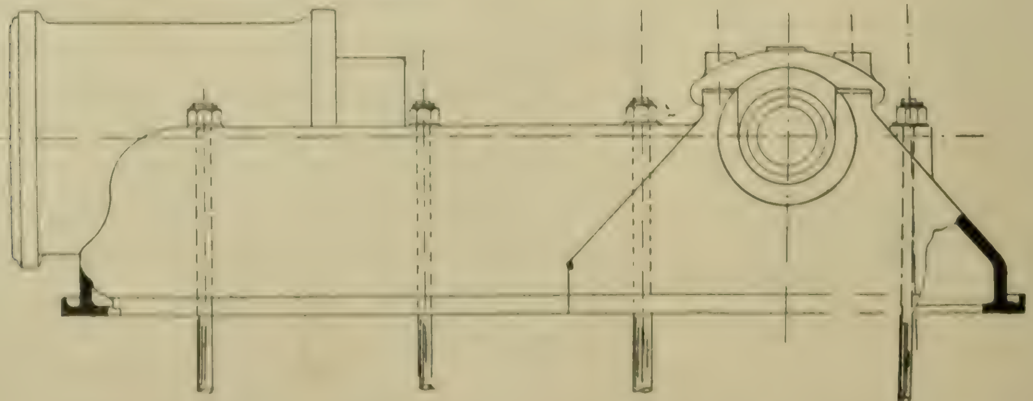


FIG. 5. BED FRAME, SHOWING MINIMUM OVERHANG OF CYLINDER.

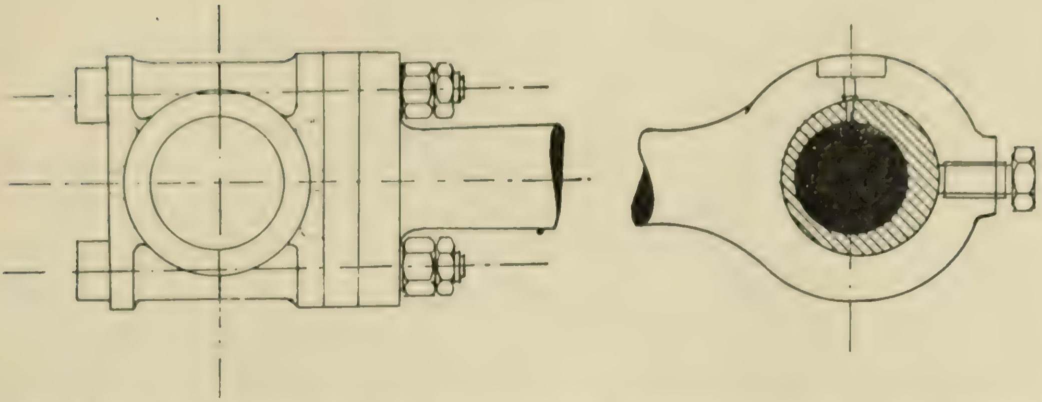


FIG. 6 AND 7. CONNECTING-ROD BEARINGS FOR ENGINES BELOW 30 HORSE POWER.

Bearings and Guides.—These should be bushed with brass or babbit metal. Their design should permit easy adjustment for wear and tear. For single-cylinder engines of above 100 horse power, side shaft-bearings should be provided with ring lubrication.

Connecting Rod.—The connecting rod should be of mild cast steel. For engines below 30 brake horse power, the head bearing may be of the marine type (Figure 6), of gun metal, and the foot bearing may be made with independent bushes held in position by a set screw (Figure 7). For larger engines, the head of the connecting rod should be cut and turned out of plain metal, then split and adjusted with bolts. For securing an accurate fit, copper foil should be fitted between the two parts of the covers. The brasses should be made in two parts, with cast-steel shells lined inside with babbit metal (Figure 8). The foot bearing should be cut out of the metal and fitted with brasses of good bronze (Figure 9).

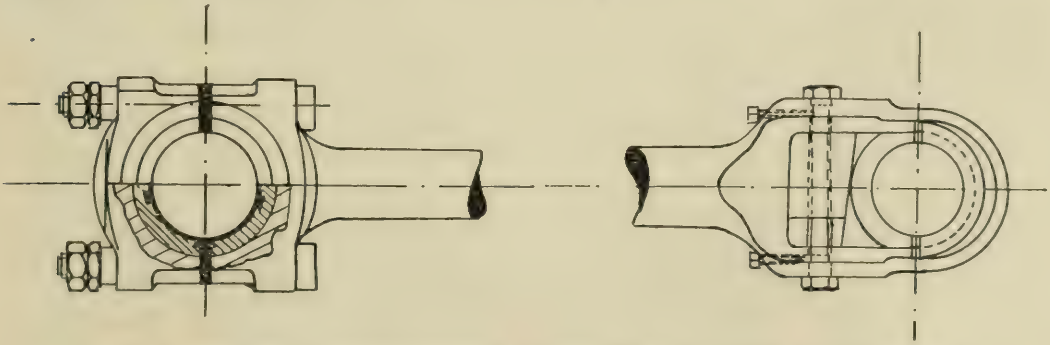


FIG. 8 AND 9. CONNECTING-ROD BEARINGS FOR LARGE GAS ENGINES.

Cylinder Heads.—For high-compression engines (above 100 to 110 pounds) of more than 600 horse power, the cylinder head should be provided with a separate and independent water supply and outlet pipe for cooling. The exhaust pipe also should be partially water-jacketed. In all suitable parts provision should be made for large openings in view of easily removing the core after casting and also

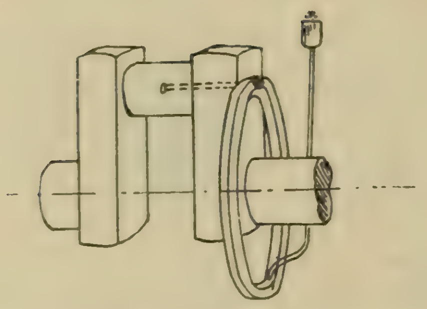


FIG. 10. CRANK-PIN LUBRICATION.

of securing a thorough cleaning of the inner walls and removal of the scale and lime deposits.

Cylinder.—The cylinder should be provided with an independent lining of very hard cast iron. An indicator hole should be located in an accessible part and provided with a ¾-inch Whitworth tap. The indicator hole should be closed by means of a spindle, the inner end of which should be level with the lining, in order to avoid any accumulation of gas in the canal.

Lubrication.—All the rubbing surfaces should be automatically oiled by continuous sight-feed lubricators. The lubrication of the crank pin or connecting-rod head should be provided by means of a centrifugal ring fixed on one of the crank webs and provided with a suitable plug to allow cleaning (Figure 10). The piston pin should be oiled with an independent sight-feed lubricator of the wiper type (Fig. 11). The piston should be provided with a visible and adjustable supply of oil, by means of an oil-pump forcing the oil under pressure; this pump should be positively driven from the engine, any mechanical device except a system of pulleys and belts which are liable to slip being satisfactory. The pump should be designed for both hand and mechanical operation in view of allowing lubrication of the piston prior to starting the engine. The tank supplying the oil to the pumps should be provided with a gauge glass indicating the amount of its contents. The bottom of the oil tank should be provided with a filter to prevent dust or rubbish from getting into the cylinder. The end of the inlet pipe should be provided with a sight-feed and a check valve to allow for easy dis-

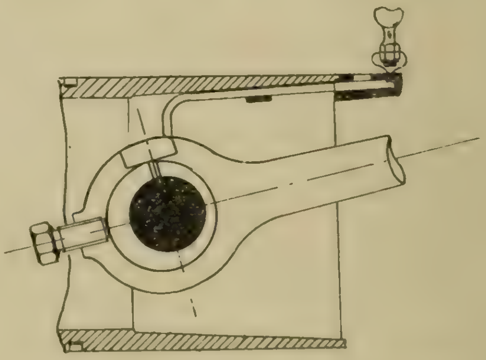


FIG. 11. PISTON-PIN LUBRICATION.

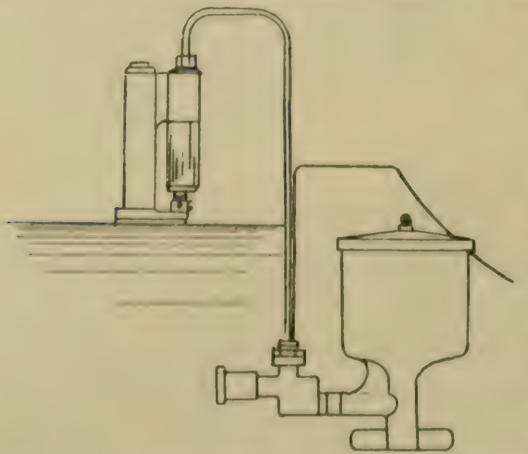


FIG. 12. SIGHT FEED AND CHECK VALVE ON OIL PIPE.

mantling during the working of the engine in case of obstruction (Figure 12). The capacity of the oil cups or reservoirs should be sufficient to ensure the lubrication of the several parts for at least five hours working under full load without having to renew the oil.

An oil gauge with a drain cock should be fitted to the oil tank which should be deep enough to allow free deposit of the dirt. The spindles of the gas- and air-inlet valves and more especially, the spindle of the exhaust valve, should be provided with an efficient and easily controlled oiling device.

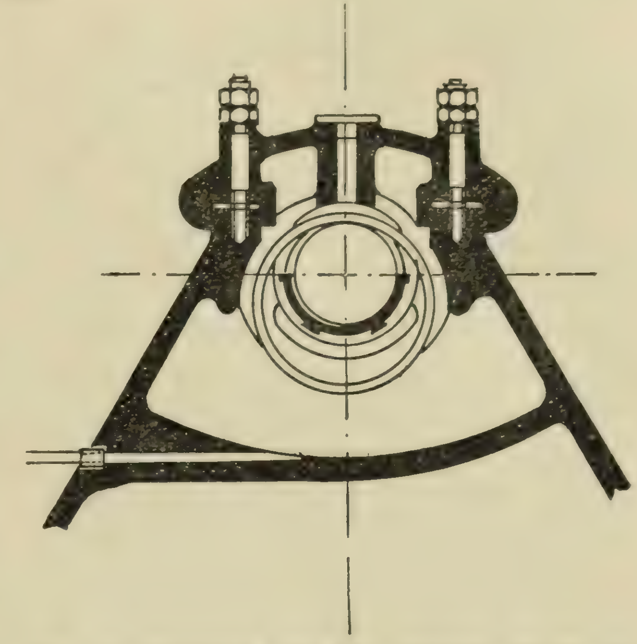


FIG. 13. BEARINGS AND CAP, ENGINE BELOW 30 HORSE POWER.

For engines ranging from 25 to 30 horse power, the main bearings of the crank-shaft should be of the ring-lubricating type with a single ring and should have plain bronze brasses; the cover may be held by two studs and double nuts (Figure 13). For larger engines ranging from 45 to 50 horse power, two rings should be used for each bearing and four studs for holding each cover. The bushes should be steel shells lined with babbit metal.

Joints.—All joints necessary in the several parts of the cylinder head or the combustion chamber should be "dry," the metal surfaces being directly ground and of such a design that regrinding shall be possible after the installation of the engine.

Piston.—The piston should be provided with at least five soft cast-iron rings for engines below 20 horse power and with at least six rings for higher powers. The piston pin should be of the best-quality steel, case-hardened 1/16- inch deep and it should be rectified on the grinding mill. The pin should be secured in only one boss, by means of one or two set screws. The use of wedges or clamping screws liable to work loose and injure the cylinder must be avoided.

Governor.—The governor may be of the inertia type for "hit and miss" engines under 15 horse power. Above this power the governor should be of the centrifugal type. The governor should be sufficiently sensitive and efficient to limit the variations in the number of revolutions, between full load and idle running, within 3 per cent if the engine is governed by hit and miss, and 5 per cent if the engine is governed by variable admission. Belt-driving should not be admitted and worm gears are to be preferred to bevel gears. In the case of variable admission, steadiness of the governor should be obtained by means of a dash-pot or oil piston, provided with a proper arrangement of the by-pass to allow regulation without stopping the engine. A set spring should also be fitted to the governor to regulate the speed within the limits of 5 or 10 per cent of the regular number of revolutions of the engine.

Regulation.—Governing by variable admission of a constant ratio of mixture is preferable in engines above 50 horse power when fed with producer gas and should be applied in any case to engines above 25 horse power when fed with town gas.

Valves.—The valves should be easily accessible and located for easy dismantling with a view to quick and thorough cleaning. They should be mechanically operated except in the case of arrangements similar to that of the Koërting mixing valve. The spindles should be fitted with oiling tubes; for engines above 50 horse power, these tubes should be fitted with sight-feed oilers, with a view to preventing fouling of the spindles or abnormal wear. That of the exhaust valve must be well cooled by water circulation. The spindle and its mushroom should be machined in one piece out of plain steel.

Rubbing Surfaces.—The surfaces of all friction parts should be made sufficiently large to prevent heating and wear. The following table of intensity of thrust should be applied in calculations of surfaces. An initial explosive pressure of 350 pounds per square inch of piston area is taken as a basis.

	Pounds per square inch.
For the piston pin	3,000
For the crank-shaft journals	600
For the crank-pin	1,600

This thrust is considered as relating to the projected surface, i. e., diameter multiplied by length.

Flywheels.—These should be accurately turned and set at the rim and at the boss. For engines of the "electric type," the rim should be slightly rounded to carry a belt for driving the dynamo. The rim velocity, in this case, should not exceed 500 feet per minute. The projecting parts of the keys or key ways should be protected by an envelope or cap fitted around the shaft. When the weight of the flywheel exceeds 4 tons, it should be provided with a moving gear

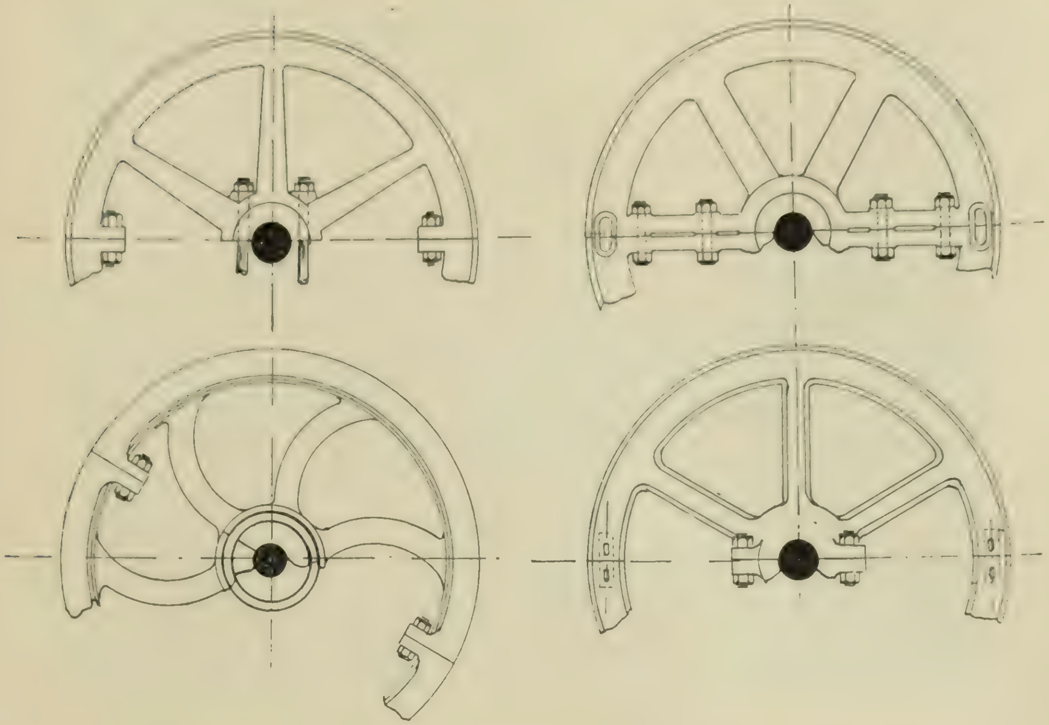


FIG. 14 TO 17. METHODS OF BOLTING TOGETHER THE HALVES OF FLYWHEELS.

which renders it possible for one man to put the flywheel at the starting point. For engines of the "industrial type" of less than 30 horse power, the crankshaft may be provided with one or two overhanging flywheels. In larger engines as well as in the "electric" types of driving dynamos, there should be a single flywheel supported by a third external bearing. In such a case the driving pulley should be fitted between this bearing and the flywheel. This pulley should be cast in two pieces. For engines above 50 horse power the flywheel should be in two halves joined together by bolts and hoops at the boss and at the rim in accordance with a design similar to any one of those shown in the accompanying illustrations (Figures 14, 15, 16, and 17).

When arranging a gas engine to drive a constant-current dynamo, it must be remembered that the current supplied to incandescent lamps should insure a light of perfect steadiness, without the necessity of making use of accumulators, no matter what power between 1/3 of the full load and the full load, is developed. Under these conditions, the engine must have such a cyclic regularity as to prevent variations of more than 2 per cent in the readings of aperiodic ammeters or voltmeters. The allowable amount of variation in a single revolution of the fly-wheels is as follows:

For ordinary industrial purposes....................	1/25 to 1/30
For electric lighting by continuous current........	1/50 to 1/60
For spinning mills and the like.....................	1/120 to 1/130
For alternating-current generators in parallel......	1/150

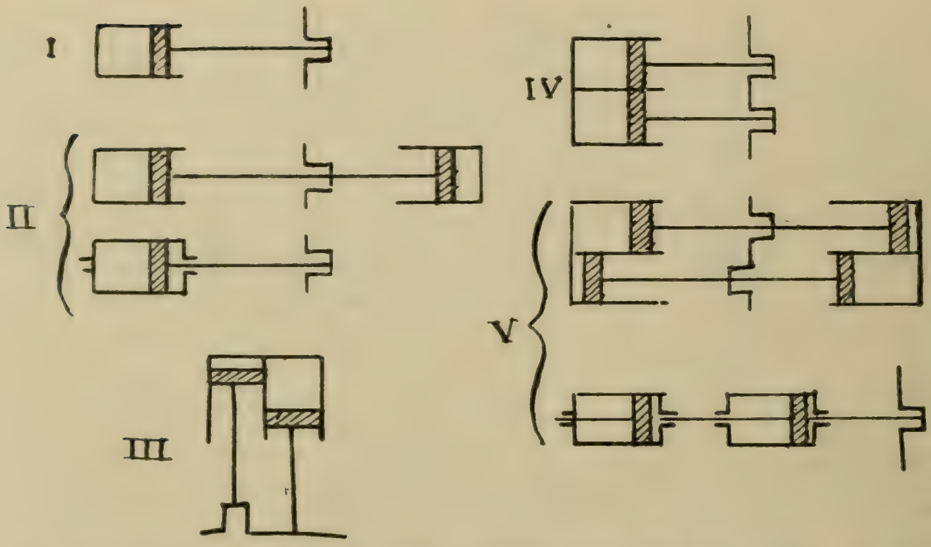


FIG. 18. DIAGRAM SHOWING CYLINDER ARRANGEMENT FOR THE TYPES OF ENGINES BELOW.

The following formula should be applied for the determination of the dimensions of the fly-wheels of the different types of engines.

$$P D^2 = K \frac{N}{a n^3},$$

hence

$$P = K \frac{}{D^2 a n^3},$$

in which

P = the weight of the rim (without arms or boss) in tons;
D = diameter of the centre of gravity of the rim in metres;
a = the amount of allowable variation;
n = the number of revolutions per minute,
N = the number of brake horse power,
K = coefficient varying with the type of engine.

I K = 44,000 for Otto-cycle engines, single-cylinder, single-acting.
II K = 28,000 for Otto-cycle engines, two opposite cylinders, single-acting, or one cylinder double-acting.
III K = 25,000 for two cylinders single-acting, with cranks set at 90 degrees.
IV K = 21,000 for two cylinders, single-acting.
V K = 7,000 for four twin opposite cylinders, or for two tandem cylinders, double-acting.

The total weight of the fly-wheel is P x 1.4. For diagram showing the arrangement of cylinders, see Figure 18.

BOUNDARY CREEK, FROM WHICH THE COPPER DISTRICT TAKES ITS NAME.

METHODS OF MINING IN THE BOUNDARY DISTRICT, BRITISH COLUMBIA.

By Frederic Keffer.

The great demand for copper caused by the growth of the engineering industries, especially by the enormous increase in the development and use of electric power, has stimulated the production of the metal to the utmost. One of the most interesting phases of this increase has been the profitable mining of ores so low in grade that formerly they would have been ignored as valueless. This success has been attained only by the introduction of methods devised by the highest skill and ingenuity, and it is most appropriate that these should be described by a mining engineer who, like Mr. Keffer, has taken part in the work and is today successfully prosecuting it. His article in this number on the mining methods will be followed by another dealing with the subsequent treatment of the ore.—THE EDITORS.

THE Boundary Creek mining district of southern British Columbia includes, generally speaking, the country between the North Fork of the Kettle River on the east and the main river on the west, and from the International boundary to some 25 miles north. The creek from which the district takes its name occupies a valley about midway between the two branches of the Kettle River, the creek itself entering the Kettle River on the International boundary, whence its name. The country, though mountainous, is not rugged; the hills seldom reach a height above 6,000 feet, and are rounded by heavy glaciation and erosion.

GENERAL VIEW OF THE MOTHER LODE MINE, DEADWOOD CAMP.

The mineral deposits may be divided into two main classes. The first consists of narrow veins occurring in fissures within granite rocks or between the contacts of these rocks and adjoining greenstones; these veins contain usually lead, iron, and zinc sulphides together with high values in gold and silver. The gangue rock is usually very silicious. The second class includes deposits of irregular form and frequently of enormous extent, containing copper as chalcopyrite ($Cu Fe S_2$), iron sulphides as pyrite or pyrrhotite, and iron oxide as magnetite; the gangue minerals being mostly calcite, quartz, garnetite, epidote and greenstones. These ores carry 1 to 3 per cent of copper, and from $1 to $3 in gold and silver. It is the mining of these latter ores which forms the subject of the present paper.

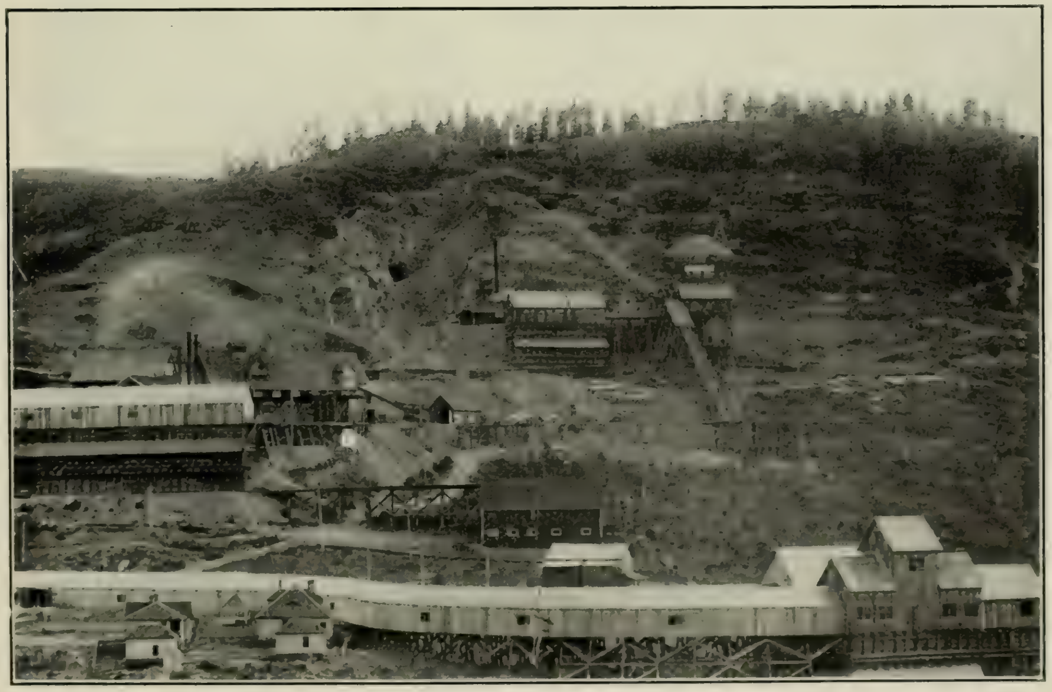
In Deadwood Camp the largest ore body, (that on the Mother Lode claim) lies between limestone on the west and greenstones on the east, and dips east at an angle of approximately 70 degrees.

The origin of the ore is apparently to be found in replacement of both limestone and greenstone by ascending mineral-bearing solutions. In Phoenix Camp, the enormous ore bodies appear for the most part to be volcanic ash beds, subsequently mineralized by copper-bearing solutions. These beds have usually dips of from 35 to 70 degrees, and often lie roughly parallel to the slope of the containing hills. In Summit Camp the Oro Denoro deposit is probably similar in origin to those of Phoenix and lies approximately parallel to the slope of the hill, while the ore on the adjoining claim, the Emma, is between the contact of lime and greenstones, and stands vertical.

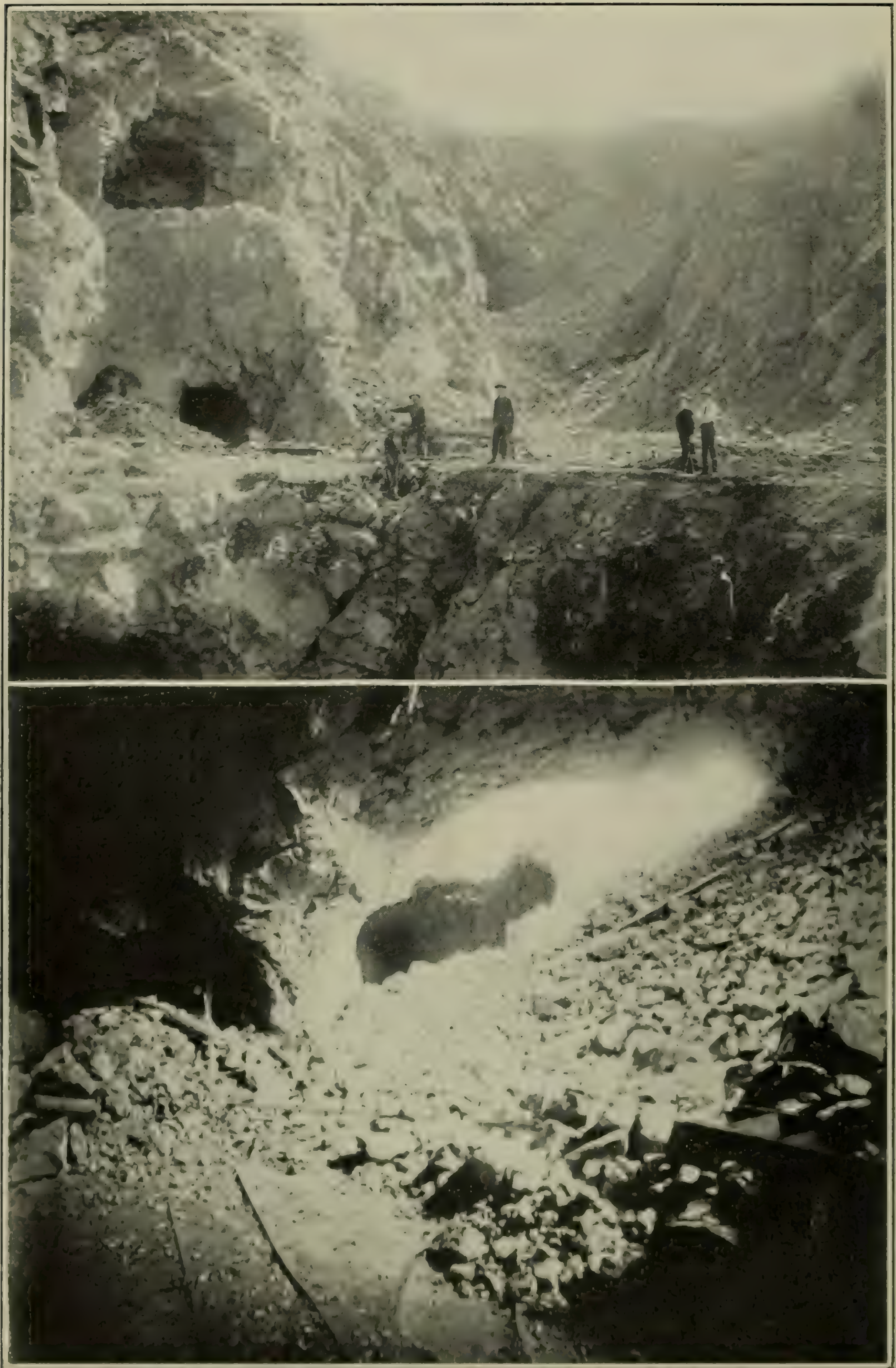
There are as a rule no definite walls to the ore bodies, the mineralization fading gradually away into the country rocks. Limestone contacts, however, are generally sharper than greenstone ones, the limestone appearing to have been more impermeable to the mineralizing solutions. The walls are thus really commercial ones, being the points where it does not pay to mine the ore further; and naturally the price of copper will to some extent govern the positions of the walls. Ore bodies are frequently separated by wide zones of entirely barren rock, and this, coupled with their irregular forms, has led to the general adoption by the larger mines of diamond drilling as a means for locating new deposits. Great dykes of alkali porphyry frequently accompany the ores, sometimes presenting to the miner problems of ore extraction which puzzle his ingenuity to the utmost to solve.

These stratigraphical features are briefly summarized here inasmuch as they have an intimate bearing on the mining of the ores, as well as on their discovery through development operations.

Four general conditions have contributed to the successful mining and smelting of these low-grade ores, the absence of any one of which would render their working nearly or quite unprofitable. These conditions are: (1) the enormous extent of the ore bodies, making



GENERAL VIEW OF THE GRANBY MINE, PHOENIX, B. C.



THE GLORY HOLE, AND UNDER THE GLORY HOLE, GRANBY MINES, PHOENIX.

mining on a huge scale possible; (2) the solidity and firmness of the ground which makes the opening of great stopes without the use of timbers not only feasible but also safe; (3) the chemical composition of the ores which, through rendering them self-fluxing, obviates the use of any barren fluxes; and lastly (4) the proximity of the district to the vast coking-coal fields of the Crows Nest Pass.

Other contributing though not essential aids are abundant electric power, plentiful water and timber, dry mines requiring little pumping, and an unsurpassed climate.

The methods employed in mining may be classed as follows:

1.—Open pits or "glory holes."

2.—Rock pillars and stopes.

3.—Timbering sill floors under stopes: (a) wholly, (b) partially.

Glory Holes.—This method of ore extraction is feasible only where the overburden of soil or barren rock is not too great, and is best carried out in mines where the dip of the ore deposit is high; otherwise the perpendicular wall of the glory hole on the hanging-wall side of the ore will quickly intercept the foot wall, making the pit come to a point; and it is not practicable for reasons of safety to follow the ore in an open pit underneath the hanging wall.

In opening up the deposit for glory-hole work, a tunnel or drift is run under the ore at a depth if possible below the point where the perpendicular wall and foot wall will come to a point. Raises are now run near the foot wall from this tunnel or drift or from its branches, to the surface, which raises are provided with chutes at the bottom. Having filled the raises with ore the rock can then be blasted around their collars, funnel-shaped openings being formed which grow deeper and wider as the work progresses; care must be taken to keep the raises full of ore so as to prevent big rocks from getting into them, thus choking the chutes. The drill holes are run from 6 to 20 feet deep, and before being blasted the deeper ones are "chambered" by exploding several sticks of dynamite at their bottoms; when the holes have cooled off, for which abundance of time is allowed, the chambers are filled with dynamite, often as much as 25 to 50 pounds to a deep hole, and fired. Usually but one or two deep holes are blasted at a time so that the broken ore may be properly "bulldozed", which operation consists in breaking the boulders of ore by exploding 60 per cent dynamite on top of them, the dynamite being covered with fine ore or sand. If the boulders are very large, they are "blockholed" with a "baby" drill, or often with a light pneumatic hammer drill. Although one stick of dynamite exploded inside a rock is much more effective than several exploded on top of it, it does not pay to block-hole any but the larger boulders, the powder being less costly than the labor, when breaking small rocks. By keeping the sides of the tunnels sloping about 45 degrees the ore may be carried into the raises with little or no shoveling, a very important saving thus being effected. Instead of the ore being funneled into the raises, it is sometimes loaded in cars and dumped into them; the Granby Company at Phoenix successfully used steam shovels in one of its glory holes, loading the ore in dump carts for transportation to the raises.

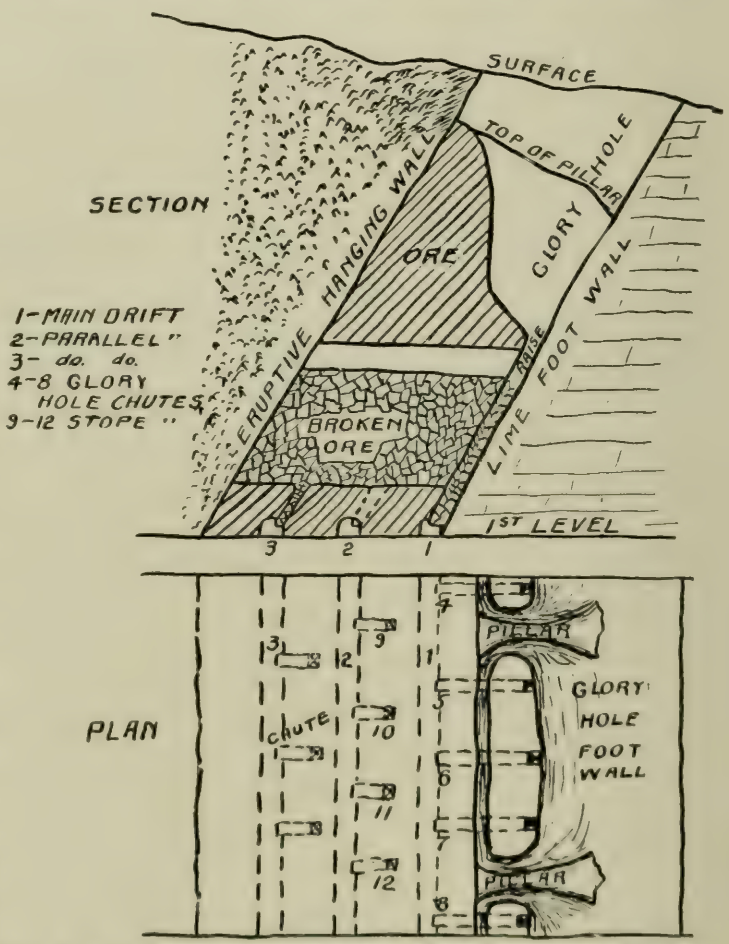


FIG. I. PLAN AND SECTION ABOVE FIRST LEVEL IN MOTHER LODE MINE, SHOWING GLORY HOLE AND STOPE.

It is important to cool the chambered holes before reloading, nor should these holes in ores carrying high percentage of lime be cooled by water prior to loading. One severe accident came under my notice which could be traced to no other cause than the heating of a cold chambered hole through the action of water on the quick-lime produced by the burning powder during the chambering process. In this instance it was thought to make the hole surely safe by pouring in cold water prior to loading, but apparently the reverse effect was obtained.

Figure 1 is a cross section of one of the glory holes at the Mother Lode mine, which illustrates the general plan followed.

Rock Pillars and Stopes.—Owing to the low dip of many of the deposits, it is evident for the reasons stated above that the period of glory-hole work is necessarily limited, and that sooner or later underground mining must begin. Square-set timbering being out of the question on account of its prohibitive cost, the usual plan is to open stopes above a roof supported by pillars of ore.

Owing to the great irregularity in form of the deposits each section of the work, even in the same mine, must be treated individually and plans made to suit the form and dip of the ore contained in that section. In mines where the dip of the ore is over 60 degrees, as in the Mother Lode, it is the practice to run two or three or sometimes even four approximately parallel drifts under the ore to be extracted, the number depending upon the width of the ore body. From these drifts raises are run at intervals of about 30 feet, these raises being provided with timbered chutes at their bottoms, the chute openings being usually 4 by 2½ feet in section and lined with ¼-inch steel plate. About 10 to 12 feet over the backs of the drifts, stoping is started in the various raises and ultimately all the growing stopes unite in one large stope. Up to this time practically all the broken ore has been drawn from the chutes, and also at a convenient point a raise has been run to the next level for ventilation. The stope is carried the entire width of the ore, but pillars are

THE GLORY HOLE AT THE MOTHER LODE MINE.

left at intervals to insure the safety of the roof. A manway into the stope is also provided, sometimes in the barren rock of the walls and sometimes in a pillar, or it may be carried up from one of the first short raises by cribbing. This preliminary work having been accomplished, the stope as a whole is carried up to the next level, only the excess of ore being drawn from the chutes, which excess is about 40 per cent of the whole. The ore is bulldozed as broken, to prevent the choking of the chutes; the miners standing on the broken ore are in reach of the roof and can guard against unsafe ground with temporary stulls. In the Mother Lode the work is arranged so that when all the ore above the first level is broken down it will be drawn from the stopes, after which, beginning at the furthest point from the shaft, the pillars and the roofs over the drifts will be robbed to the limits of safety and the level abandoned as worked out. This general procedure will be followed in succeeding levels as the workings grow deeper.

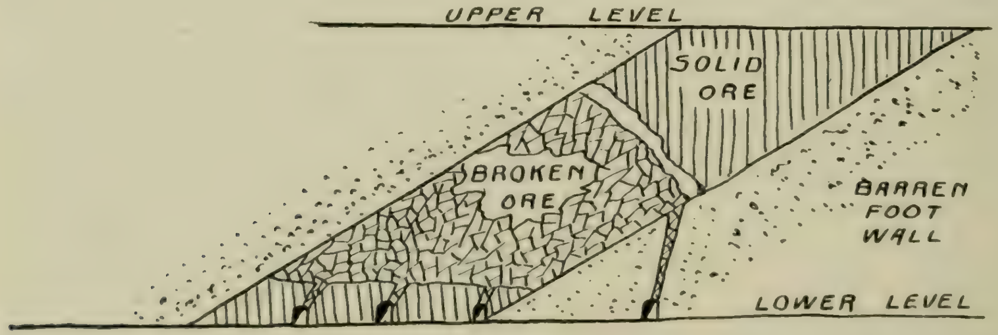


FIG. 2. SECTION OF A STOPE WHEN FOOT WALL IS SO FLAT THAT ORE WILL NOT RUN WELL.

In the Granby mines where the ore lies flatter than in the Mother Lode, it is usual to run three or more drifts under the ore to be stoped, and later on as the stope grows higher, a drift in the barren foot wall is run and raises made to reach the ore which will not run on the foot wall by itself. In this way shovelling the ore is mostly avoided, much reducing the costs of mining. Figure 2 illustrates the plan of extracting the ore along these lines.

Timbering Sill Floors.—(a) Wholly. In this method of extraction the ore is first removed from over the floor of the level to a height of about 12 feet. This floor is then heavily timbered and the ore broken down on the timbers until the level above is reached, only the "swell" of the ore being removed through chutes suitably placed as the work progresses. This method, while well adapted for small ore bodies, is scarcely to be recommended for big stopes, partly on account of the expense involved, but mainly because the load is too heavy for safety unless the timbering be made tremendously solid and massive.

(b) Partially. Two variations of this method may be followed:

1. The sill floor being wholly cut out as just described, timbered ways are built, these ways being solidly lagged over the tops and sides. The ore above is then broken down over and between the ways, the sill floors thus carrying the bulk of the load. Chutes are maintained at intervals along these timbered ways. Figure 3.

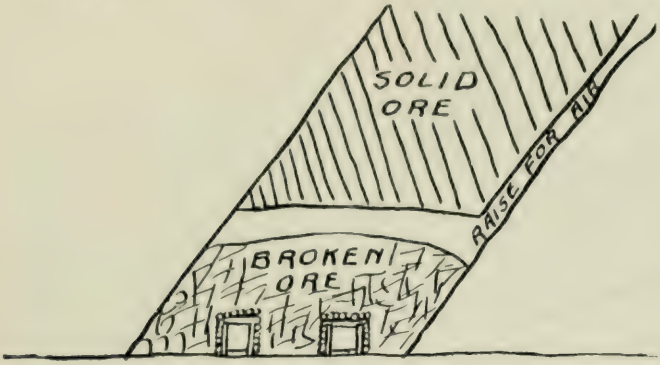


FIG. 3. SECTION OF A STOPE WITH TIMBERED WAYS.

2. The second variation is followed to some extent in the Emma mine, where the ore stands vertically and is from 20 to 35 feet across. Here a single drift is run 10 to 12 feet wide along the ore. This drift is carried high and is roofed with very heavy stulls placed at intervals of 5 feet, and supported below by one or two posts to each stull. The stulls are covered with heavy pole lagging, and chutes provided at intervals of about 25 feet, the chutes being first on one side and then on the other of the drift. Stoping is then started, the stopes being widened in V shape until the walls are reached, when the work is carried up as usual. In this way the major part of the weight of broken ore is borne by the walls. Figure 4. In other sections of this mine the entire sill floor is timbered. As may be imagined, mining in this perpendicular deposit presents fewer obstacles than with those having considerable dip. The necessity for frequent support to the hanging wall through cross pillaring is here

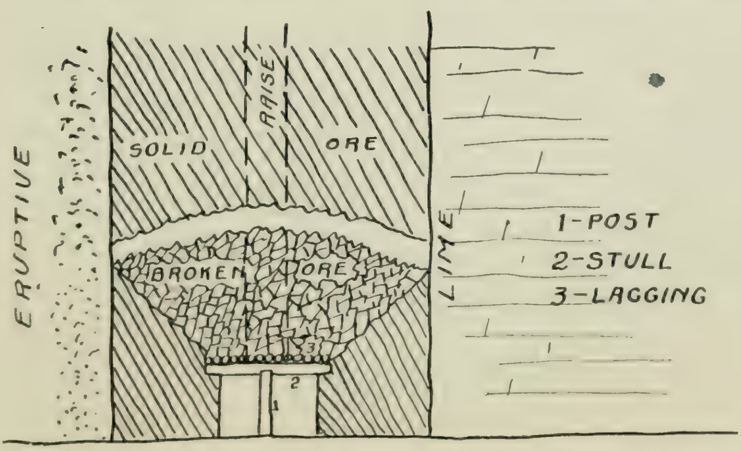


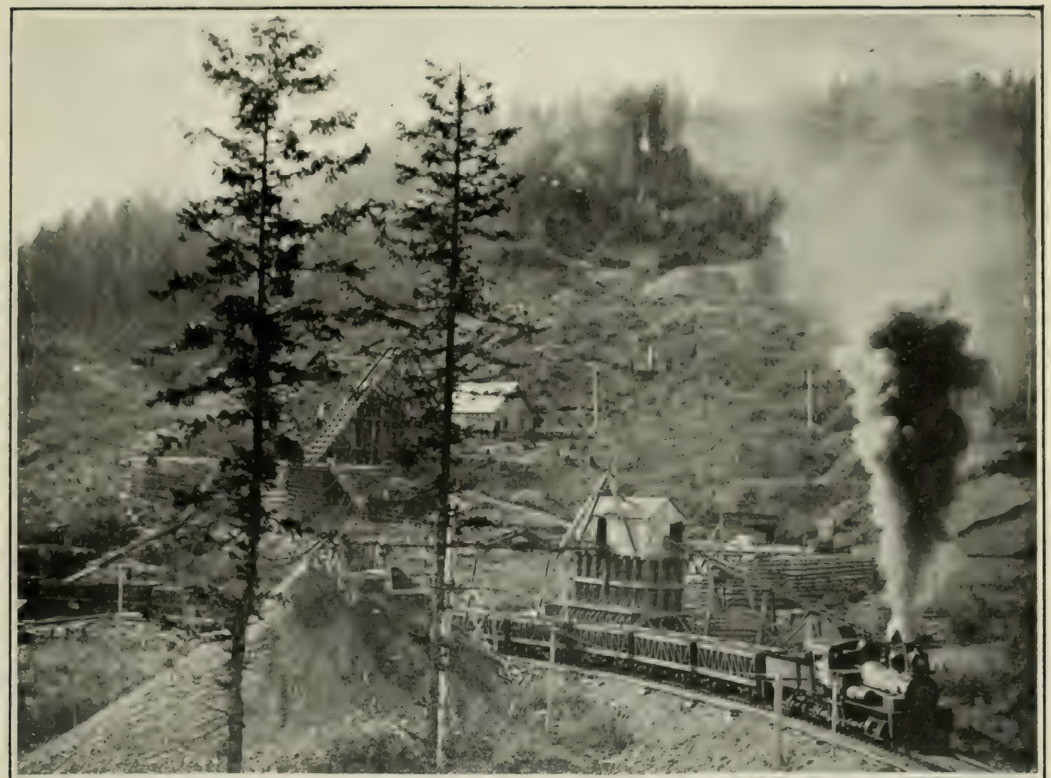
FIG. 4. SECTION OF STOPE IN EMMA MINE, WITH CENTRAL DRIFT COVERED WITH STULLS AND LAGGING.

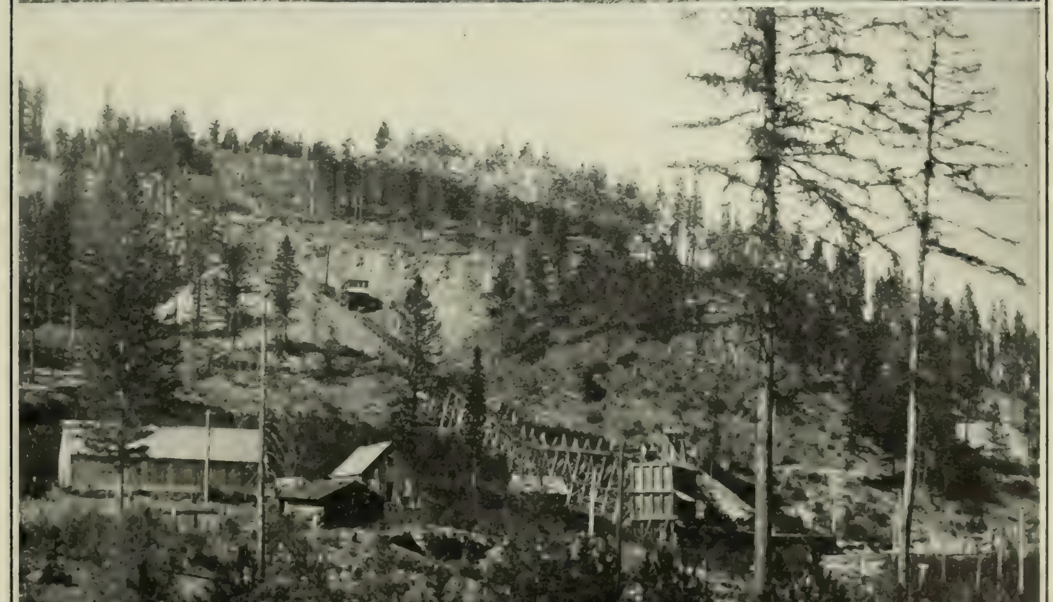
absent, and there is never any difficulty due to the ore refusing to run into the chutes.

Ore Handling.—In the Mother Lode mine all the ore, both from the glory holes and underground workings, comes to the main shaft where it is dumped into capacious pockets, smaller pockets being provided for waste. Several classes of cars are used. The most numerous are broad and low and of scoop pattern, capacity 2 to 2½ tons. The second class are side-dumping cars, capacity 3 to 3½ tons each. They are drawn by horses in trains of 4 to 5 cars.

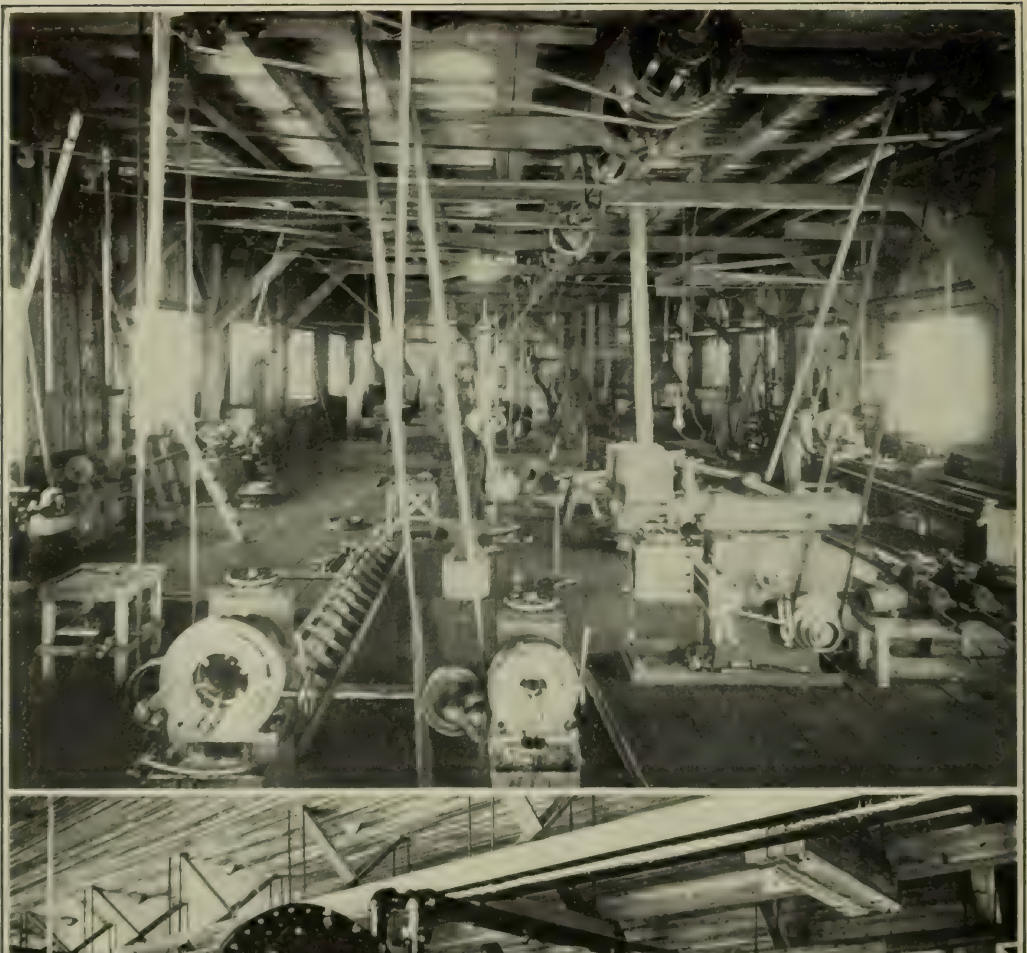
HEAD WORKS OF THE MOTHER LODE MINE.

The scoop cars on reaching the pockets are dumped by a tipple which after dumping throws the cars back on a side track. The side-dump cars are emptied as the train passes over the pockets, and are more rapidly handled than the scoops. These two classes of cars are built of ¼-inch steel plate with a double bottom consisting of two ¼-inch plates separated by 2 inches of planking. Besides these cars there are many 1-ton ordinary mine cars pushed by men where horses are not available. The ore is drawn from the pockets into 5-ton skips, and hoisted to a bin at the surface, whence it passes to either of a pair of electrically driven Blake crushers having jaw openings of 24 by 36 inches. The "fingers" to the chutes feeding the crushers are operated by compressed air, so that the crusher feeder has perfect control over his work. Lifts are also provided to turn around boulders





SNOWSHOE MINE, GRANBY COMPANY, PHOENIX.
RAWHIDE MINE, DOMINION COPPER COMPANY, PHOENIX.



MACHINE SHOP AND COMPRESSOR PLANT, GRANBY MINES, PHOENIX.

The compressor plant is for two 30-drill compressors.

of ore which happen to fall in such a way that the jaws cannot take hold. From the crushers the ore falls onto a 36-inch conveyor belt which takes it to the railway bins 175 feet distant. The main shaft has four compartments each 4½ by 5 feet, two of which are for skips, one for ladder and pipe road, and the last for hoist cage. So far as possible the loading pockets communicate with the hoist by speaking tubes, enabling the skip loaders to direct the hoistman on occasion.

TEMPORARY COMPRESSOR PLANT, EMMA MINE.

In the Granby mines most of the haulage is done by electric motors and steam locomotives, which pull trains of 5 to 10 cars of capacity from 5 to 10 tons each. At two tunnel entrances to the mine on upper levels, bins are located in connection with which are enormous crushers with jaw openings of 30 by 42 inches, the crushed ore passing into railway bins. Connecting with the lower levels of the mine is a three-compartment incline shaft which will shortly be in commission. Here the ore is hoisted to a pair of bins whence it passes to a giant jaw crusher and thence over a long conveying belt to the railway bins. An ingenious device in the head-frame at this shaft is a rotating bin near the top of the frame into which the ore or waste falls from the skips, and which by rotation delivers the contents of the skips into any one of three chutes as desired. Two of these chutes communicate with the bins above the crusher, while the third is for waste.

At the Dominion Copper Company's mines the ore is not crushed,

HEAD FRAME OF BOLTED PLANKING, MOTHER LODE MINE, IN CONSTRUCTION.

but is delivered directly to the railway bins, the crushing being all done at their smelter.

The air compressors, crushers, some hoists and most of the minor machinery are operated by electricity which has all but displaced steam power in the Boundary. Two plants supply this power. The smaller, operated by the Cascade Power Company, is located at Cascade Falls in the Kettle River about 25 miles from the centre of the mining district. The capacity of this plant is 2,000 to 3,000 horse power, depending somewhat on the season. The line voltage is 20,000. The larger power plant is that at Bonnington Falls in the Kootenay River, some 85 miles from the centre of the Boundary district. It is estimated that 60,000 horse power is available here at low water.

The general progress of mining in the Boundary (which ten years ago was practically a forest wilderness remote from any railway) can perhaps most impressively be illustrated by the following table of tonnages smelted at the three plants operated by the Granby, Dominion and British Columbia Copper Companies. For so young a district this is certainly a creditable showing.

Year.	Tons smelted.
1900	62,389
1901	348,439
1902	460,940
1903	697,404
1904	837,666
1905	982,877
1906	1,276,589
Total	4,666,304

THE PROPERTIES AND USE OF MINERAL LUBRICATING OILS.

By P. F. Walker.

Professor Walker's suggestive studies of lubricants fittingly round out a "Power and Production Number"; for the elimination of friction, in which lubrication plays a large part, is one of the very important elements in economy of production through the application of power.—THE EDITORS.

THE lubrication of the moving parts of high-grade machinery is coming to be of more and more importance as machines are being perfected, and as closely guarded systems of works management throw into prominence many hitherto unheeded sources of inefficiency and loss. Reduced friction losses effect savings in many different directions. They serve to increase the effective power from a given motor, or to make it possible to use smaller sizes, to reduce repair items incident to heated bearings, to prolong the life of the machine, and to reduce stresses in power-transmission machinery, thus permitting the use of lighter parts. Beyond a doubt the future will see much more attention given to the whole subject of lubrication than is now accorded it.

Probably no other questions connected with the operation of machinery are so poorly understood by engineers as a class as those involved in the selection of a lubricant for any special work. What has proven good in one place may not do so in another, or at least, it may not do as well as some other that may be found. A common failing of engineers is to conclude that an oil is the best which prevents a bearing from giving trouble by heating, has good lasting qualities, and costs little, without taking the trouble to find out if it is superior to other available brands in friction-reducing qualities. The failure to take this last matter into account is almost a natural outcome of conditions, since it is a tedious and costly process to test thoroughly, in actual service, the numerous oils which would be submitted in response to any general call for samples and bids. What is wanted is some simple test to be applied quickly and easily, which will give some positive information as to the real value of the lubricant.

The ordinary simple physical tests, consisting of the determination of congealing and flashing temperatures, loss by evaporation, and detection of acidity, are purely discriminative by nature. They serve to distinguish oils totally unfit for the conditions to be met, but a dozen samples might pass these tests with practically equal merit and no clue be given as to the real lubricating values. The determination of viscosity appears more promising in positive results, but even here attempts to draw definite conclusions are disappointing. Undue stress is often laid on viscosity values as indications of the value of lubricants, and many misconceptions exist as to the true significance of this property of oils. It is my purpose to point out in some measure, in this article, the real meaning of viscosity, as well as to refer to the significance of the flash point as a test of lubricants.

In passing it may be noted that many practical men attach too little importance to friction tests for lubricants on special machines. Unreliable as these tests may be in respect to furnishing absolute figures for frictional resistance in actual service, they do give comparative results which are positive indications of the values of different oils in reducing friction, which no other test can do. The vital conditions of pressure on the bearing and relative speeds of the surfaces in contact may be realized at will on the special machines, and because nearly all conditions are readily controlled on these machines, fairer tests will be secured from them as regards comparative lubricating qualities than will result from making brief trials on the actual machinery where conditions are liable to vary. Many machines for this purpose are on the market at reasonable prices. In selecting a machine it should be kept in mind that it is the oil that is to be tested, not the bearing or the actual friction coefficient to be expected in practice. This being the case, the machine should be constructed with special reference, first, to making the application of the lubricant to the bearing positive and absolutely perfect, and second, to the securing of good control of the temperature of the oil on the bearing. These two features are all-important. If the lubrication is not perfect in the machine there is no way of telling how imperfect it is, and the test becomes only a measurement of friction between partially oiled metal surfaces, instead of a test of the oil. Perfect lubrication is secured when the oil film is continuous, entirely supporting the journal, and to secure this condition the bearing should be flooded with oil, or, better still, be immersed, in full or in part, in an oil bath. The necessity for the perfect control of temperature arises from the fact that the viscosity of the oil varies with the temperature, and no comparison of oils can be a true comparison unless corresponding conditions in this regard are realized. Since in bearings furnished with a limited supply of oil the film between the surfaces is bound to be of higher temperature than the metals of the bearing and journal, it is evident that temperature control can be best secured under the same conditions as are necessary for perfect lubrication; that is, by flooding the bearing, or immersing it. In this way the temperature of the film will be very nearly that of the oil flowing from the bearing. Temperature control is the most difficult of realization of all the necessary conditions in an oil-testing machine, and there is no absolutely perfect method possible; but the above is unquestionably the nearest approach to perfection.

In addition to the tests for the real lubricating properties, the machines are sometimes used for testing the durability of the oil, its capacity for conducting away the heat caused by friction, and the relative efficiencies of different methods of applying the lubricant. In my experience, however, these tests are unsatisfactory when made on the special machine, for the simple reason that they are influenced by the nature of the bearing, and what may be good for the special machine may not be good for the bearings on which the oil is to be used. If it is definitely understood that the special oil machine is to be used to measure the friction in continuous oil films surrounding the journal, and to determine the pressures under which an oil will form those films when conditions are perfect according to some standard method of application which is always possible of realization, then the misconceptions as to the significance of results, and suspicions as to their correctness and worth, will disappear. The machines may be used, of course, as they have been in the past, to establish laws of friction for lubricated surfaces under various speeds, pressures, temperatures, or viscosities; but in doing this perfect lubrication must be secured if the results are to be of practical value for all classes of service. There are no laws of friction for imperfectly lubricated surfaces, and it is useless to test oil under anything but standard conditions.

Mineral lubricating oils constitute the greatest portion, by far, of the fluid lubricants used in this country. Practically all of these are produced from crude petroleum by distillation and subsequent treatment to remove solid paraffine and other objectionable constituents.

The crude petroleum used in the United States as a source of lubricating oils has a paraffine base, and the products obtained by distillation follow in a general approximate manner the order of the paraffine series, the chemical composition of which is expressed by the symbols C_nH_{2n+2}. With these, however, are associated, in varying amounts, unsaturated hydrocarbons of the ethylene and acetylene series, C_nH_{2n}, and C_nH_{2n-2}, respectively. The lighter distillates, forming the naphthas, gasoline, and kerosene, seem to follow closely the paraffine series, the latter product being composed largely of the nonane, C_9H_{20}, and the decane, $C_{10}H_{22}$. The heavier, later distillates are, however, extremely variable in their natures, showing evidences of the presence of large quantities of the unsaturated hydrocarbons. When the distillation of these heavier oils is carried on in a vacuum the fluctuation seems to be less erratic, but still there is more or less definite evidence of the presence of members of the lower series of hydrocarbons in some of the products. The effect of the vacuum is simply to lower the temperature at which the distallates pass over, thus diminishing the tendency of the oil to break up in chemical composition.

A peculiar fact brought out by the distillation processes, and one which is significant in relation to the lubricating-oil question, is that if the residue remaining after driving off the lighter oils (including most of the lubricating oils) be taken and redistilled destructively—that is, "cracked" as expressed in the ordinary vernacular—there may be recovered a complete series of distillates from the lightest gasoline down. This cracking process is a breaking down, chemically, of the oil, occasioned by too rapid heating in the still. It can be prevented only by the greatest care and skill. This shows that during the distillation for lubricating oil there may come over with the oil some of these lighter volatile products. Their presence lowers the flashing temperature which marks the limit of the usefulness of the lubricant, and increases loss by evaporation and tendency to gum.

The flash test reveals the presence of these volatile liquids, and is one of the most valuable of the physical tests. That some of the lighter substances are present in all our common mineral oils classed as engine oil or lighter, is shown by the fact that their flash points are always below 425 degrees F. The distillation for the production of kerosene is stopped at about 572 degrees F. at atmospheric pressure, and it is evident that if the heavier oils formed a regular series with the lighter ones they would yield no oil vapor to ignite below that temperature. The extent to which these volatile substances enter into the oil is indicated by the flashing temperature, and this test is thus really a test of the skill and care exercised by the manufacturers.

The low limit of temperature permissible for the flashing point of oil to be used on bearings is not a definitely fixed value. It must depend upon the conditions at the bearing. In places where heating is at all likely to occur in a noticeable degree, the safety of the bearing demands that the oil should retain its lubricating qualities at comparatively high temperatures. Since the temperature of the oil film is always much in excess of that which can be measured in the metal body of the bearings, the safe limit for flashing is higher than might at first be supposed. A figure sometimes mentioned is 300 degrees F. but this is too low for most classes of high-grade machinery.

The above discussion of low flashing points is based entirely on considerations of the power of an oil to lubricate at all. There is involved, however, a matter of greater moment than this, greater because the condition is more commonly realized. At temperatures only moderately high the loss of the oil by evaporation becomes considerable. If this evaporation is sufficiently rapid it will cause gumming and a gradual increase in the viscosity, which means an increasing friction loss, followed by greater heating and faster evaporation in a cumulative manner. This occasions a greater consumption of oil, and in continuous systems of lubrication where the oil is used over and over again, it is especially harmful. In engine-crank cases, for instance, the temperature may become comparatively high, and a volatile oil will gradually change in its friction-reducing qualities, to the detriment of the engine and ultimate waste of a large amount of oil. Actual evaporation tests of oils are tedious, and require accurate balances for weighing the samples, as well as good facilities for maintaining constant temperatures during long periods of time, but the flash test which is very easily made may be made to serve in an approximate manner for comparative purposes. In this connection the results of tests made by students under my direction are expressive. The tests were of thirty-hours duration, the oil being in shallow trays set in a bath of water for the lower temperatures and of oil for the higher. Each sample of oil weighed about 80 grammes at the beginning of the test.

RESULTS OF EVAPORATION TESTS.

No. of oil sample.	Density at 60° F.	Flash-Point. Closed cup.	Flash-Point. Open cup.	Evaporation loss in 30 hrs., %. 150°	200°	250°
1	.902	354°	416°	0.4	0.4	1.0
2	.867	340°	372"	0.4	0.6	2.2
3	.872	272°	290°	3.2	12.4	24.2

Figure 1 shows graphically the variation in evaporation loss with the flashing temperatures of the oils. The results from the closed-

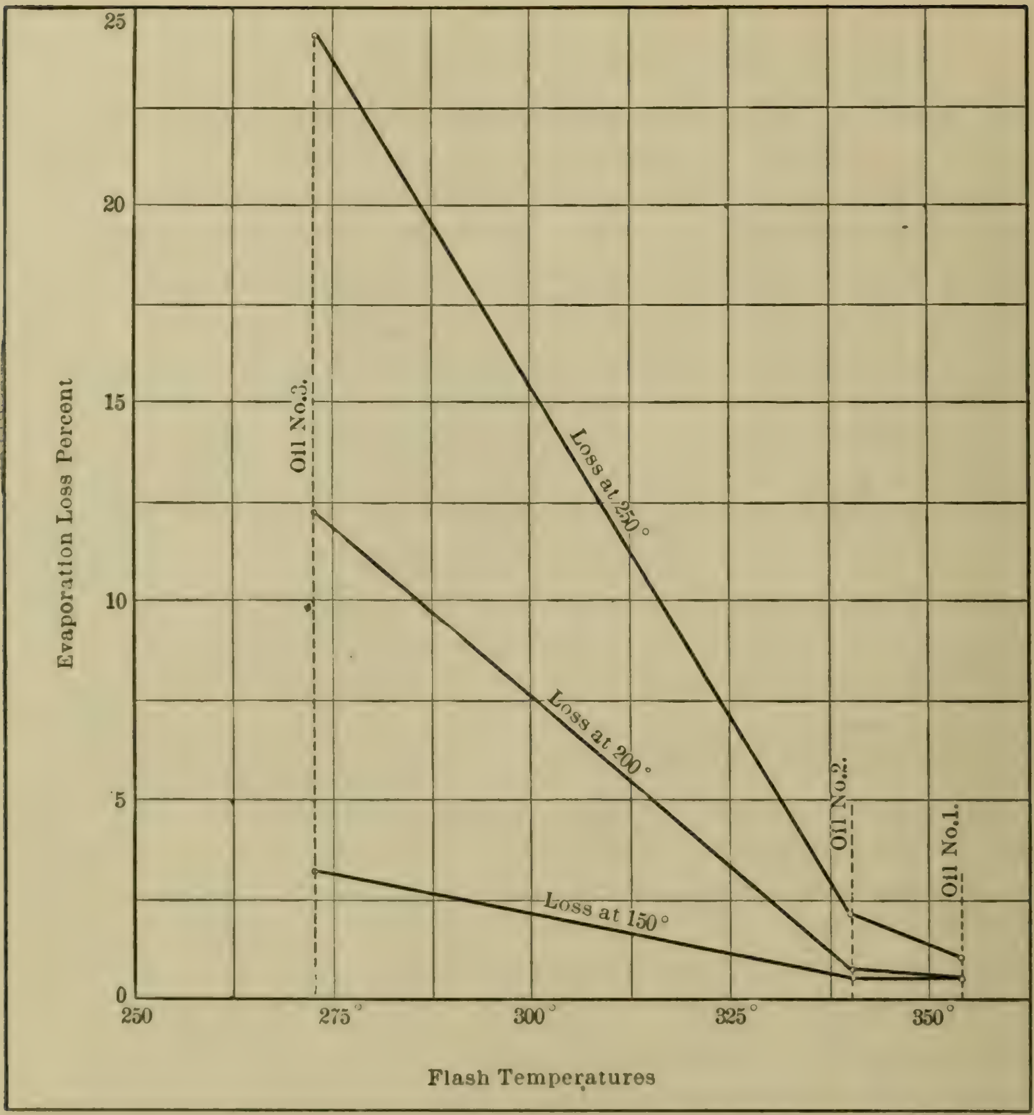


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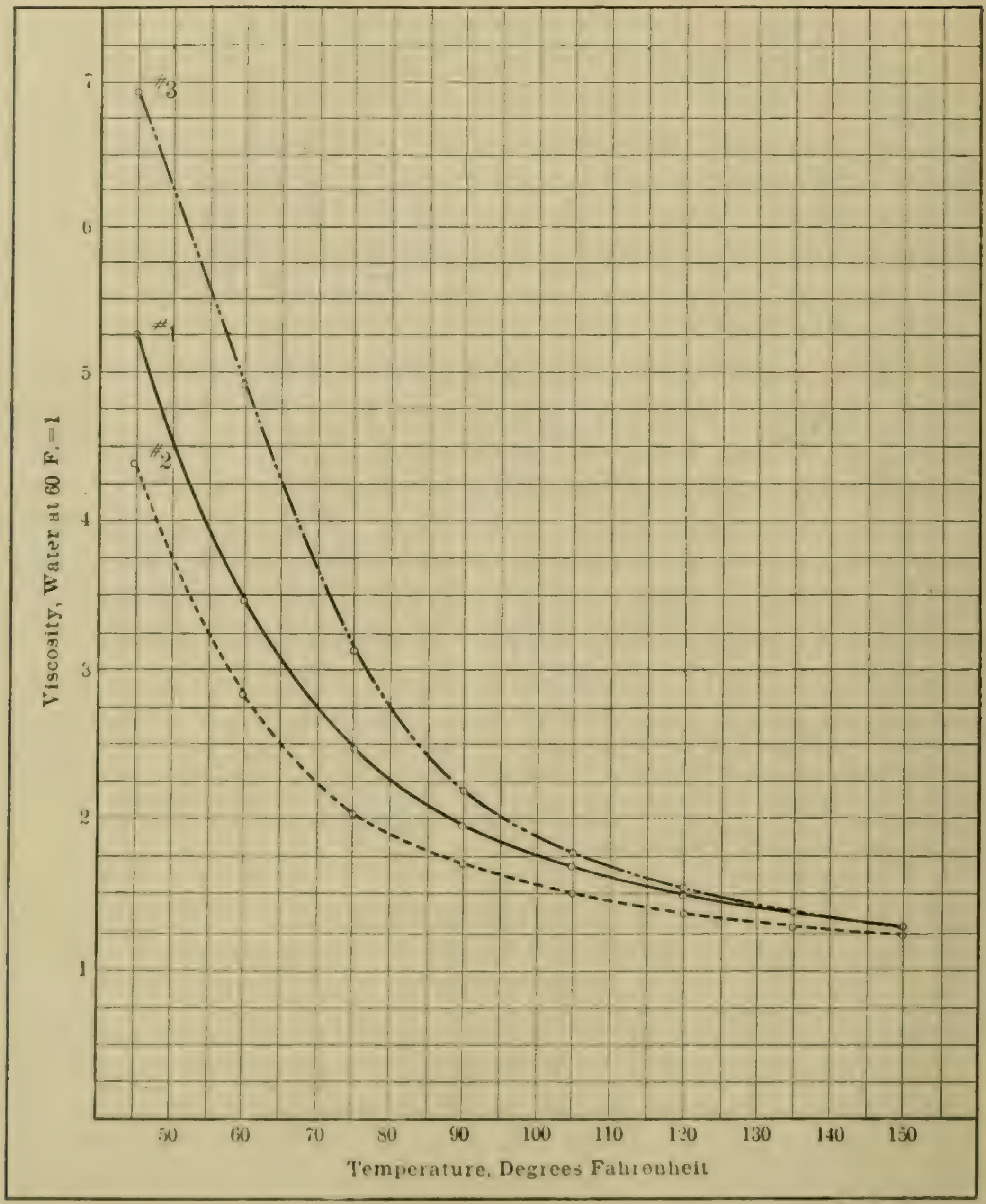
FIG. I. GRAPHIC RECORD OF EVAPORATION LOSS OF DIFFERENT OILS.

cup method of determining the flash point are here used, but the open-cup results would show the same degree of variation. The points for the different oils are connected by straight lines, since three points are hardly sufficient to determine the nature of a curve in an unexplored field like this, but the indications are that the three points for each temperature at which the loss was determined lie on a curve hyperbolic in form, and approaching parallelism with the horizontal axis at the right. The results which have been found for a fourth oil of higher flash temperature than Number 1 confirm this view. It is not probable that the loss would become zero, even for oils of very high flash point, when the temperature is held at 200 degrees or over, because of the chemical unstability of mineral oils. As it stands, however, the diagram shows plainly the marked increase in evaporation losses with oils of low flash points, at temperatures not uncommon in ordinary bearings. It should be remarked that oil Number 3, with the low flash point and high evaporation loss, was a paraffine oil, so-called, which had not been treated by chilling or otherwise to remove solid paraffine or other natural constituents. The point is well established by these tests, however, that evaporation losses are greater for low flash points, although there are insufficient data to establish numerical relationships.

Oils, or other liquids, act as lubricants in virtue of their ability to form continuous films over the surfaces to be lubricated. In some cases, as in engine-cylinder lubrication, the film must be formed through the tendency of the liquid to spread over a solid. In other cases the oil is drawn between the surfaces by the motion of the parts, and it becomes more a question of the oil-film's ability to withstand the pressure applied to it without being forced out or without allowing the surfaces to come into contact. It follows, then, that the lubricating properties of oil are more properly considered as properties of films than of masses of oil of considerable thickness. The investigation of the properties of thin films of oil has received but little attention, hence the present uncertain condition of our knowledge of the absolute friction-reducing properties of oils.

The properties of the film which tend to resist its ejection from between two surfaces where it has been carried, are viscosity and the tensile strength of the film. Viscosity is the measure of the force required to move one layer of a liquid over another layer of the same liquid, whether those layers are infinitely thin or of appreciable thickness. In other words, it is the shearing strength of the liquid, taken along the plane parallel to the direction of motion. Evidently, then, an oil of considerable viscosity offers a greater resistance to any force or pressure tending to expel it from between two surfaces than does one which has a lower viscosity, and consequently an oil of high viscosity will permit the exertion of greater unit pressures on a bearing without being driven out.

The tensile strength of the film resists the tendency of irregularities in the surfaces to rupture it, and likewise, if the film should be thus broken or greatly thinned, causes the oil to reform the film after the irregularity has passed. Undoubtedly this film strength bears a definite relation to the strength of the film which forms on the free surface of a liquid, or on the surface separating liquids of different densities. This latter property of liquids causes it to rise into small



The Eng Magazine

FIG. 2. GRAPHIC RECORD OF VISCOSITY TESTS ON SEVERAL OILS.

tubes and around the edge of a containing vessel, and is often called capillarity. By the physicist the strength of the film thus formed is called "superficial tension," or merely "surface tension." Lord Rayleigh, the eminent English scientist, has done a great amount of work in this direction, and he has shown that when several liquids of different surface-tension values are in contact, equilibrium exists when they are arranged in the order of their surface-tension values, the liquid with the lesser value spreading over the one with the higher value. Metals, having high surface tension, will thus be covered by most fluids, which have smaller values. Mercury, however, which has a very high surface tension, does not spread over the solid metals.

This tendency of liquids to spread over metals in films more or less thick, which tendency is measured by the superficial tension, is a valuable one in a lubricant, although it has been shown that the friction-reducing qualities are not in direct proportion to the surface-tension values. In the lubrication of a steam-engine cylinder it is an all important property, and hence cylinder oils should be high in surface tension, especially since they must resist the tendency of water of condensation, with its high surface tension, to displace the oil film in order to satisfy the conditions of equilibrium discovered by Lord Rayleigh. Fortunately water does not form stable films.

One more characteristic of oil films between surfaces moving relatively to each other should be noted.

In continuous films between surfaces, one of which is at rest and the other in motion, either actually or relatively, the shearing force set up is proportional to what is called the rate of distortion. This rate of distortion is simply the ratio of the distance moved by one thin layer over another in unit time, to the thickness of the layer. Therefore the greater the number of thin layers, or the thicker the film, the less will be the shearing force, and hence the less resistance, or friction, in the bearing. This may be seen by placing a pack of cards on a table and with the hand on the uppermost one, moving the whole to one side. For a given movement of the uppermost card and a given thickness of the cards, the more cards the less each one moves on its next neighbor. Hence, in the case of fluid friction, the less will be the resistance to motion, and it follows that oils which form thick films are the best lubricants, other things being equal.

To summarize, for an oil to be a good lubricant for a given service it should have the following characteristics:—

The least viscosity consistent with the pressure to be sustained.
The ability to form thick films.
Readiness in forming films over metal surfaces, and power to resist rupture.
A flashing temperature sufficiently high to avoid loss by evaporation, varying consistency, gumming, etc.

The characteristic of most importance in a given case depends upon the conditions of pressure, and methods followed in applying the lubricant.

Surface tensions of lubricating oils are seldom determined, but may be found by drawing a small, clean glass tube from the oil and measuring the force required to separate it from the oil by attaching it to one arm of a delicate balance.

Viscosity is usually measured by the time required for a given amount of the oil to flow through a standard orifice, referred to some standard fluid. Figure 2 gives the results of a series of tests carried out under my direction by a different group of students at a different school from that in which were made the evaporation tests already discussed. In this work, however, oils Number 3 and Number 2 are from the same refiners and of the same grades as are Number 1 and Number 2 respectively, in the evaporation tests. Oil Number 1 in the present series is lard oil.

It is seen in Figure 2 that as the temperature rises the viscosity values approach each other, becoming nearly coincident at 150 degrees F. Extensions to these curves made later, at temperatures up to 350 degrees, bring the values still closer.

Figure 3 shows the actual coefficients of friction for the same oils, under varying pressures. These values were taken on a machine designed by Professor Carpenter of Cornell University, in which the bearing rests on top of a journal about 4 inches in diameter. The width of the bearing was 2 inches, thus enclosing about one-sixth of the circumference of the journal. The bearing was of brass, and the journal steel. This form of bearing permits high unit pressures with little danger of heating.

This diagram presents some interesting features. Up to about 200 pounds per square inch the oil of least viscosity shows the smallest coefficient, as is to be expected. Above this pressure the oils change relative positions, confining our attention to the two mineral oils, Numbers 2 and 3. The reason for this is not entirely clear. The first thought might lead one to the opinion that the oil of less viscosity had reached its limit of pressure-sustaining qualities, and that for the higher pressures it was being forced from the bearing and lubrication becoming less perfect. To treat the question fully, however, the temperature in the bearing must be considered. Temperatures were taken by a thermometer placed in a cavity in the side of the bearing, but not in contact with oil in the bearing proper. Hence the true temperature of the oil film must have been considerably higher than those recorded. At pressures of 200 and 250 pounds per square inch the temperatures at the ends of the runs were about 85 degrees and 100 degrees respectively, as recorded, which means that the probable temperatures of the oil films were considerably higher. This would

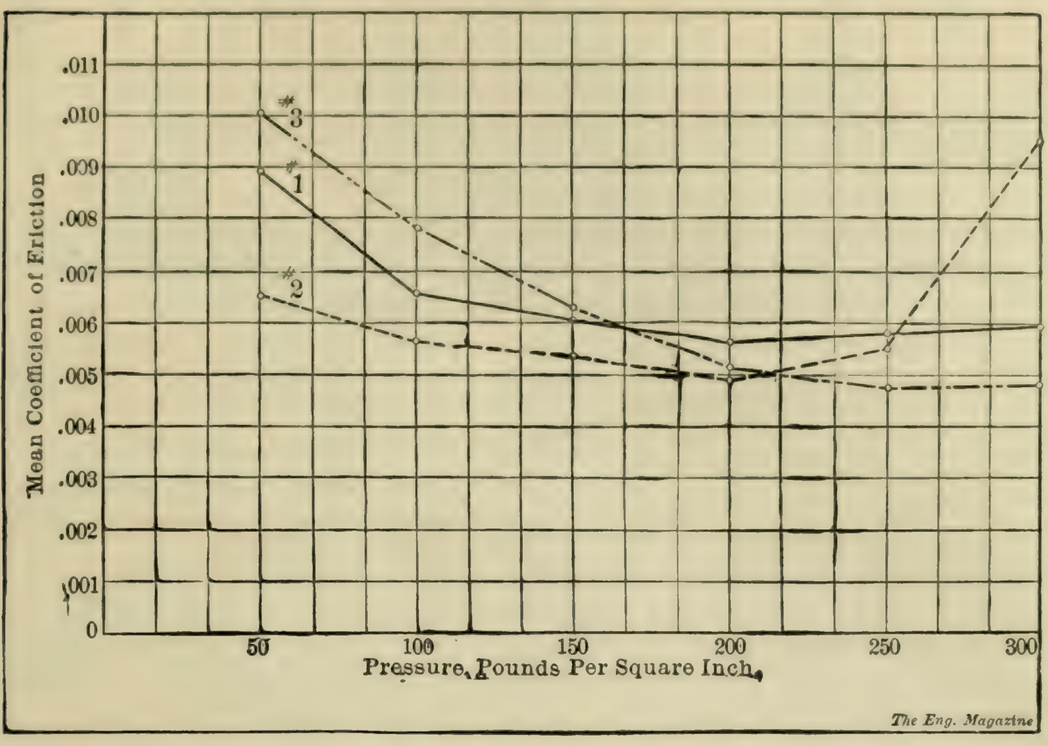


FIG. 3. FRICTION COEFFICIENTS OF OILS WHOSE VISCOSITY IS EXHIBITED IN FIGURE 2.

bring the oils to a position on the viscosity curve, Figure 2, where the viscosities were approaching each other. For the runs at 300-pounds pressure the temperatures were such that the viscosities would be practically equal. It therefore seems doubtful if differences in viscosity were sufficient to account for the marked differences in the friction. Without doubt the lubrication became less perfect with oil Number 2 at the high pressure, but in my opinion this was due more to differences in the film-forming powers of the oils at the high temperatures than to differences in viscosities.

The above serves to illustrate in a striking manner the many difficulties and pitfalls in the way of the oil tester, and also to drive home the conviction that there is still much to learn in the lubrication field. So far as I am aware no work at all has been done with films, in the manner that seems necessary to explain many of the phenomena observed. It is largely my purpose to point out in the present article the need of more work in all phases of the oil question, and especially in the direction of the film-forming properties. An interesting field of work awaits the man who, with sufficient time at his disposal, takes up these phases of the question.

EDITORIAL COMMENT

THE movement for reducing the risk to life and property in hazardous occupations should receive a strong impetus through the action just taken by the United States Geological Survey. An experiment station is to be established, probably in the Pittsburg district, for thorough practical tests of all explosives used in coal mining, the candle power and relative safety of miners' lamps, and the efficiency and life-sustaining power of rescue apparatus. Miners will be given instructions and demonstrations in the rescue of their fellows. The knowledge secured through experimenting on a really large scale will be disseminated with the object of reducing the number of mine disasters arising from gas and coal-dust explosions.

The explosives gallery will consist of a boiler-plate cylinder, 100 feet long and 6 feet in diameter, with safety valves on hinges along the top to allow escape of the gases of explosion, and plate-glass covered port holes on the sides through which an explosion may be seen from the observation gallery 60 feet away. Suitable gauges will record the actual pressures developed; the temperatures of explosive decomposition will be measured, the rate of detonation determined by a rotary recording drum, the length of the flame photographed. From the data secured will be determined the maximum quantity of each explosive that can be used safely, and the results will be published under the head of "Permissible Explosives."

Under Mr. J. A. Holmes, chief of the technologic branch of the Survey, the work will be in charge of Dr. Charles E. Munroe, Mr. Clarence Hall, explosives expert, who has just returned from the study of similar work abroad, and Mr. W. O. Snelling. It promises much for greater safety in coal mining.

* * *

THE disturbing rumor of bad foundations for the Gatun locks which has appeared at several critical periods is finally silenced by the report presented by Messrs. Noble, Stearns and Freeman, on their return from their recent examination of the ground. The assurance from such authorities that (to quote from their brief and direct report) "all of the locks, of the dimensions now proposed, will rest upon rock of such character that it will furnish a safe and stable foundation" is completely satisfying.

They add a detailed statement of the examination and the results. At Gatun, five test pits about 6 feet square had been sunk to or below the level of the lock walls. The deepest was 87.4 feet in depth. All entered rock a few feet below the surface of the ground and continued in it to the bottom. The three consulting engineers personally went down into each pit, and they found everywhere, with one exception, a fine-grained, bluish-gray rock which Mr. Ernest Howe calls an "argillaceous sandstone." The exception was a conglomerate found in the lower 8 feet of test pit No. 1. The quantity of water percolating into the pits was of no practical importance.

At the site of the Gatun regulating works the same blue-gray argillaceous sandstone was found; under the Pedro Miguel locks the same rock is interrupted by a trap dike which will furnish support the greater part of the length of the lock walls, while the Sosa locks will rest wholly upon the hard trap. Thus Mr. Stevens' report to the Senate Committee is most amply confirmed.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE EFFECTS OF THE SAN FRANCISCO EARTHQUAKE AND FIRE ON BUILDINGS.

A SUMMARY OF THE CONCLUSIONS REACHED AFTER EXTENSIVE INVESTIGATIONS BY A COMMITTEE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

Proceedings of the American Society of Civil Engineers.

RECOGNIZING the value of the professional lessons which were to be learned by a careful study of the effects of the San Francisco earthquake and fire on all classes of engineering structures, the American Society of Civil Engineers, shortly after the disaster, instituted an investigation of the subject through a committee of the local Association of Members. The report of this committee was presented at a recent meeting of the Society and presents a great deal of authoritative information of the highest importance. The report is divided into sections dealing with geology, buildings, water works, sewers, lighting and street railway transportation, railway structures, and highway structures. The following extracts are taken from the general summary of the section on buildings which is the largest and most important feature of the report.

"The effect of the earth motion is to set a building in motion. The structure is thus subjected to all the stresses occurring in a truss sustaining a live load. The amounts of the stresses are unknown, and cannot be predicted, as the intensity of the shock is unknown. Obviously, the shock may range from a tremor to that of a violence that would wreck any building. Again, should the earth-slip take place beneath a building, it would be wrecked. Sufficient evidence is at hand to warrant the statement that a building designed with a proper system of bracing to withstand wind at a pressure of 30 lb. per square foot will resist safely the stresses caused by a shock of an intensity equal to that of the recent earthquake in California.

"The prime requisite of the structure is elasticity. This must be understood as the ability of a structure to return to its original form after distortion. This elasticity allows the building to absorb the motion of the earth, where a more rigid structure would be ruptured.

"To this requirement, the building with a timber or steel frame answers very well. The reinforced concrete structure does so also, with the exceptions noted below. The building with stone, brick or block construction, having horizontal mortar joints, does not answer the requirement at all. It may be stated, as one of the most obvious lessons of the earthquake, that brick walls, or walls of brick faced with stone, when without an interior frame of steel, are hopelessly inadequate. As a method of building in earthquake countries, such types are completely discredited.

"To resist the shearing effect of the horizontal earth motion, vertical members are necessary. The shear is transformed into diagonal forces, which appear as stresses in diagonal and horizontal members. There was probably no better illustrated lesson of the existence of diagonal stresses than that offered by the innumerable instances of the cracking of brick and stone work along diagonal lines. In relation to this, it may be stated that a brick spandrel wall adds little, if any, to the bracing of a steel frame. Many such walls were cracked badly, and moved on the supporting girder. No reliance should be placed upon them, as they are open to all the objections stated in connection with brick walls in general. The well designed steel frame offers the best solution of the question of an earthquake-proof building, as all the stresses can be cared for. The well-designed timber-framed house is also adequate. A reinforced concrete building offers a solution, but is open to the following objections:

"Architectural reasons demand that diagonal bracing shall not be used except on rare occasions. This is overcome by the use of gusset plate knee braces and portal braces in the steel frame. Such design induces severe bending moments in the columns and girders; and in the girders the moment may be of the opposite character to that of the floor loads, thus producing tension in the upper flange of the girder. As at present designed, no reinforcement is used at that point, and hence such a girder would be defective. Again, it will be found upon analysis that relatively great stresses occur at points where the girders join the columns, especially in the lower floors of tall buildings. Here, again, the reinforced concrete construction, as now designed, is weak. These remarks are offered more in connection with high buildings. They can be overcome by the designer in reinforced concrete. All the evidence in the recent shock favors reinforced concrete, but the writers are of the opinion that the steel frame offers the best solution of the problem.

"Foundations did not suffer at all, no instances of any damage having come to hand. Some discussion has taken place as to the advisability of making a monolithic mass under buildings. Several of these have been constructed, such as the Claus Spreckels, Mutual Savings Bank and Bullock and Jones buildings. They are all of relatively small base. It is commercially impossible to construct a monolithic base under a building, say, 12 stories high, and having a base of 150 ft. Buildings of that size and larger, with isolated pier foundations, suffered no more than others. The evidence is that foundations well built, along accepted lines, are adequate. It might be claimed that, if such had been used in large structures, the damage would have been less. The evidence does not point that way, for even if the monolithic base were sufficiently strong to resist the vertical earth motion, the horizontal motion would still vibrate the structure.

"Finally, it may be asked whether difference in workmanship was not responsible for many of the results. While it is true that good workmanship gave better results than ordinary, it is still the opinion of the writers that it was mainly a question of design. Agnews' Asylum was of brick, laid in a fair grade of lime mortar. Ten miles away, on similar ground, St. Patrick's Academy, of similar design, was of brick laid in lime and Portland cement, and there was better work than at Agnews'. The damage at the latter place was less than at the former, but, as far as use was concerned, both places were demolished. The tower at St. Patrick's Academy was of brick, laid entirely in Portland cement mortar, and the work was so well done that the brickwork invariably broke through the bricks and not at the joints; yet the tower was completely destroyed; in fact, it was the worst wrecked of all the buildings there.

"The writers simply reiterate the statement that, speaking generally, buildings of brick walls and wooden interiors cannot be built which will not be wrecked in a severe shock, it being a fault of design and not of materials or workmanship.

"Any deductions from the fire must be those based upon a general conflagration, and not those of an isolated fire. In view of the complete destruction of all materials it becomes a question as to what should be done to make a building fireproof.

"San Francisco was built probably in about the same way as other cities. It is an error to say that it was a wooden frame city, as the business district was generally composed of buildings with brick walls. In among these had been constructed the so-called fireproof structures, exposed on all sides to danger by the burning of the inflammable structures around them.

"The only statement that can be offered is that the best insurance for buildings would be the isolation of a district containing nothing but fireproof structures. A general conflagration would then be impossible. Manifestly, this is impossible in San Francisco, where business must be resumed with the least cost. In many cities it would be good insurance for men owning large buildings to combine to buy out old and inflammable structures, either demolishing or rebuilding them. Otherwise, there remains the danger of general conflagrations, such as those at Baltimore and San Francisco, in which fireproof buildings will be injured from 30 to 60 per cent.

"Turning to the individual building, the question of the exterior walls must be settled. There does not seem to be much choice of material. Architectural considerations demand the use of brick, terra cotta, or stone. With a steel frame supporting the walls at each story, any local fire will destroy the nearby facing, but it may be removed without damage to adjoining parts. This cannot be done when walls are self-supporting and the facing acts as a part of the wall. This risk of damage must always be carried, gradually becoming less as inflammable buildings are eliminated.

"There is no doubt that the steel frame is adequate for all its purposes, but it must be protected. This brings up the general subject of fireproofing, in which is involved the construction of floors and partitions and ceiling and column protection. Where any reasonable protection was given the steel frames of buildings in San Francisco the steel was uninjured, and hence the writers feel warranted in stating that it is possible to protect such a frame so that it will pass uninjured through a fire that consumes all parts that can burn.

"It was stated previously that all materials were destroyed by fire; it follows, from this, that the destruction of fireproofing must be expected and that it will have to be restored after a fire. It becomes a question, then, of selecting the material that will stand up best, for the fireproofing must retain its form, even if destroyed.

"In the writers' judgment, the column should be of a closed form, such as channels and plates. This is preferable to latticed columns. For columns, the fireproofing that will stand up best is red brick set in Portland cement mortar. Equal to this is a casing of solid concrete at least 4 in. thick, with a mesh of reinforcing metal. Examples were found in the St. Francis Hotel and Shreve Building, where the concrete was uninjured. In the Fuller Building, which was used as a paint and oil warehouse, the floors were of wood, and the columns were covered with from 4 to 5 in. of concrete. This protection held in place when the columns fell. It was completely destroyed, but the column shafts were protected. Next in order, and of equal merit as far as examples show, is the double wire lath and plaster protection, which, in the Wells Fargo Building, afforded complete protection. In many buildings, columns were protected by one layer of lath and plaster, directly applied, and then the entire column, with pipes, etc., was enclosed by the regular partition. This afforded complete protection, and the Merchants' Exchange and Kohl buildings are examples. The examples of the Fairmount and Alexander hotels are not included, as obvious defects in design and execution warrant the statement that the columns in these buildings were practically unprotected. The same remark applies to the melted cast iron columns of the Sloan Building.

"The remaining examples of column failures must be laid to the failure of terra cotta tile. The work in the Mills, Crocker and Aronson buildings was well done, but in all, and in the latter case especially, it failed utterly to afford complete protection. As the failure of one column section means the practical destruction of all floors supported by that column, the results are serious. In justice to the terra cotta tile, it must be said that in the St. Francis Hotel, the Union Trust and some other buildings it stood up well enough to protect the columns. The writers believe, however, that it is the least valuable of all materials commonly used for fireproofing.

"For floor construction, some form of reinforced concrete is far preferable to tile. In all cases the record of concrete is better than that of tile. Connected with this is the protection of the lower flanges of beams and girders. The fire shows that a cover of lath and plaster directly upon the flange, protected again by the suspended ceiling, is the best. The layer of plaster alone on the flange will not protect. Neither will the thin piece of terra cotta strapped on. It may be stated here that one of the most obvious lessons taught by this fire is the protection to concrete floors and floor beams by the suspended ceiling of lath and plaster. In all cases where used it afforded complete protection. Where not used, concrete was destroyed and beams were distorted.

"The subject of partitions is bound up with that of column protection. Terra cotta tiles are inferior to lath and plaster, although both were destroyed. A partition may be destroyed, but, if it stands, it impedes the spread of fire, and, in this light, the lath and plaster type is superior to tile. It should be possible to construct better partitions, but as yet no better ones have been offered.

"A logical deduction from the statement that all materials were destroyed is the conclusion that all structural parts of a building, of whatever material constructed, must be protected by another material which will be a more or less complete loss in a fire. This applies to a steel frame, to floors of any type, and to roofs. It is impossible to protect some parts, such as fronts, partitions and other parts directly exposed. The floors and frame constitute the structural parts, failure of which means destruction of the building. All such should be fireproofed. This remark applies with equal force to buildings with reinforced concrete columns, girders, beams and floors. As integral structural parts, they should be fireproofed as well as similar members of a steel frame structure, for concrete is destroyed by fire nearly as quickly as steel.

"No further comment is offered, except the following: Buildings with wooden floors will be completely destroyed in a fire. Such parts as metal trim, wire glass and steel shutters were not used to sufficient extent to warrant any definite conclusions, except to say that what showing there was was favorable. Whether this expense is warranted was not determined. Bad work and indifferent construction will cause any material to fail. Good work will enable a poor material to stand up. Fireproofing should be continuous, and at no place should it be cut into for the passage of pipes, etc. The subject of pipes should be treated as it deserves, and proper ducts and shafts should be provided, instead of allowing them to be placed anywhere where they will give the least trouble in installation."

THE VENTILATION OF SUBWAYS.

A DISCUSSION OF THE EFFICIENCIES OF THE METHODS EMPLOYED FOR VENTILATING SUBWAY TUNNELS.

M. C. Birault—Société des Ingénieurs Civils de France.

ALTHOUGH the problem of securing adequate ventilation is one of the most perplexing and important in the operation of tube railways, the question has nowhere been given the attention which it deserves. Underground railways, as a means of solving the rapid-transit problem in large cities, have increased with great rapidity in both number and extent, but without commensurate improvement and development in the details of operation. With the exception of a very few cases, the ventilation in such subways is defective and the consequent discomfort of passengers leads to endless dissatisfaction and complaint. The question has been thoroughly discussed in a paper by M. C. Birault, recently read before the *Société des Ingénieurs Civils de France.* M. Birault also discusses the ventilation of railway tunnels, but the following abstract refers only to the section of the paper which deals with city subways.

Ventilation of subways must be arranged to deal with two sources of discomfort, the vitiation of the air and its increased temperature. Vitiation is caused by the carbonic acid and moisture given off by the great number of passengers carried daily in the tubes. Organic products of a poisonous character are also found, the precise nature of which is still not thoroughly understood. The increase in temperature in subways is also due to the large numbers of passengers using them; and the friction produced by starting running and stopping the trains generates a considerable amount of heat and is another of the principal causes of the higher temperature. Particles of metallic and siliceous dust are also produced by the friction of the trains. These particles remain in the air, are violently stirred up by the passing trains, and are very liable to cause pulmonary diseases.

Experience has shown that natural ventilation is not usually sufficient to change the air of tubes which carry much traffic. It was formerly supposed that the movements of the air produced by the running trains would have the effect of drawing in fresh supplies of air from stations or other special openings. But the trains do not displace the air as they would if they acted like pistons. In double-track railways the air remains practically stagnant. The air driven forward by the head of the train immediately passes to the rear, and the current of air is in the opposite direction to that of the train. Whirling eddies of air are set up, which in all cases reduce the speed of the air current. These eddies are also to be found in single-track tubes, where, however, the general displacement of the air is in the same direction as that of the train.

M. Birault devotes a great deal of space to descriptions of the means used to ventilate the subways of European and American cities, and from the extensive and valuable data which he has gathered he is able to draw some general conclusions as to the efficiencies of the various methods of tunnel ventilation.

Moderate ventilation considerably reduces the proportion of carbonic acid and moisture in the air of subways. In some of the cities in France, where operation of trains is suspended for several hours during the night, it has been found that simply opening the doors of the stations during these hours creates sufficient draft to carry off a great part of the products of respiration. Such ventilation, however, while offering a convenient means of reducing the carbonic acid content of tunnel air, is not sufficient to carry off the bacteria and organic matter of a poisonous character which give rise to the bad odor so common in subways which are used by large numbers of passengers, nor does it materially lower the temperature. It is necessary, therefore, to arrange for a very active ventilation if all the objectionable features are to be removed, and since natural ventilation is generally insufficient, it is necessary in most cases to resort to mechanical means.

Subways may be ventilated by means of fans in one of two ways, either by installing powerful fans long distances apart, or by means of small units placed close together. Ventilation in long sections is very successful when applied, as in the case of the Central London, only during the hours of non-operation of trains. But the effect of the eddying movements set up in the air by the passage of trains running at high speeds and on close headway, is to seriously impair the efficiency of the ventilation, even in the case of double-tracked tunnels. Further, unless double doors are placed at all intermediate stations, the entrance and exit of passengers is attended by great discomfort, and additional eddy currents are set up in the air owing to the constant opening and closing of means of communication with the outside. It is advisable, therefore, to effect the ventilation of tunnels in short sections by means of small installations. In any case, the impure air should not be allowed to escape by means of the station entrances, but should be carried off through special openings and discharged at a considerable height above the street level.

It seems to be generally recognized that ventilation can be effected better by drawing out the impure air than by forcing in the pure. In most of the tunnels where mechanical ventilation is employed, exhaust rather than plenum fans are used. By this arrangement passengers enter the stations with the current of pure air instead of against the vitiated stream. In Boston, the impure air is drawn out by fans placed midway between each pair of stations, an arrangement which has given great satisfaction.

M. Birault considers it of great importance from the point of view of hygiene that the ballast of tunnels should be covered with asphalt or similar flooring. The ballast collects all sorts of impurities and being easily cast into the air as dust, is a constant menace to the health of the passengers. Furthermore, the presence of uncovered ballast prevents the easy cleaning of the tunnel which should be thoroughly washed out from time to time.

THE MARINE STEAM TURBINE.

THE PRESENT STATUS OF THE STEAM TURBINE FOR THE PROPULSION OF LARGE LOW-SPEED VESSELS.

Engineering.

IT seems to be generally considered that the marine steam turbine has failed to fulfil the claims made for it by its original advocates. Its application to vessels of large size, designed to run at high speeds, has proved a success, but numerous difficulties seem to stand in the way of its promised universal application to all classes of ships. The following extracts are taken from a recent editorial in *Engineering,* in which the general feeling of disappointment is expressed in concrete form for the first time.

"The various successful trials of turbine steamships made during the past twelve months have generally been hailed as further triumphs for the marine steam-turbine. In many respects this conclusion is entirely justified; but, at the same time, it must be confessed that the trials left matters pretty much where they were before. The pioneer turbine boat, the Turbinia, established once for all that the turbine could meet and beat the reciprocating engine when applied to the propulsion of high-speed craft. Such vessels must, however, always form but a small, if important, minority of the total tonnage of the world, and we seem no nearer than we were eight years ago to the solution of the problem of adapting the turbine to the propulsion of even the larger size of tramp steamship. From the outset it has been recognised that the difficulty has lain with the propeller. Even in the case of high-speed boats the turbine has had to be run much below its most economical speed, and this has been the case although its dimensions have been enormously increased as compared with those of equal output applied to the driving of electric generators. The maximum peripheral speed of the buckets in marine work is commonly much less than half that of a turbine employed for electric lighting; and if the same general design were followed in the two cases, the turbine should be at least four times as long if equal economy were to be maintained. Moreover, in order to get this relatively low peripheral speed at a moderate number of revolutions per minute, the diameter of the turbine has to be increased, which again involves a marked augmentation in the weight of the machinery per horse power developed. The designers have gone in this direction nearly as far as they dared, and as a consequence the total weight of the turbine machinery fitted to steamships seldom shows an advantage of more than 5 per cent. as compared with reciprocating engines. In electric-light practice the turbine unit often weighs only one-fifth to one-sixth as much as the corresponding reciprocating unit. In spite of the relatively high weight of the marine turbine, it is nevertheless, as stated, run in general much below its most economical speed; and here undoubtedly is to be found one reason for the disappointing results which have in some cases been realized in service. In no instance, we believe, has the turbine engine failed to beat, both in speed and economy, a sister reciprocating boat on the measured mile. In service, however, the latter has, in more than one instance, proved the less expensive in the matter of fuel. As the difficulty with the turbine is to get its speed down, designers have naturally selected as their speed for calculation that aimed at on the trial trip. With turbines in which the speed is maintained constant at all loads, as in those employed for electric lighting, the hydraulic losses below the governor-valve remain a nearly constant proportion of the useful work done, so that throttling the steam to diminish the output some 20 per cent. or so means no serious reduction in the economy. If, however, at the same time that the steam is throttled, the speed of the turbine is reduced, additional losses, arising from hydraulic shock, are added to those due to throttling, and the steam used per indicated horse power per hour may very rapidly augment, particularly if, as is invariably the case in marine practice, the turbine is much underspeeded, even at full power. It would appear, therefore, that specifications for turbine-boats should lay much more stress on the economy to be attained during service conditions than on the full-speed trial, and the combination of turbine and propeller should be such as to give the best economy at the relatively low service speed, even if this involves the sacrifice on the trial trip of the fraction of a knot or so."

The resistances corresponding to a given speed appear to be greater at sea than in trial-trip conditions, according to Professor Biles of Glasgow University. In the case of craft fitted with reciprocating engines, this is not a serious matter, since in general with them the propeller is of ample proportions for the thrust it has to develop. The propellers of turbine steamships, however, are often so small that quite a moderate increase in the thrust to be developed leads to cavitation and consequent large diminution in efficiency. The recent careful experiments made by the United States Navy Department have done much to simplify the problem of combining a turbine and propeller so as to obtain the greatest possible over-all efficiency. The old view, that the percentage of slip is a direct measure of the propeller losses, was again disproved by the Washington experiments. It was found that a high slip ratio, even as much as 40 per cent., is no bar to a reasonable propeller efficiency, which, even with the figure stated, may be 66 to 67 per cent. "It is not improbable, indeed, that this figure might be improved on by giving the propellers an increasing pitch from the front edge to the back. It is known that at low slip ratios there is no appreciable advantage in this procedure, but theory indicates that there might be a substantial gain when the slip approaches 30 per cent. or more. One drawback to the practice would be that the efficiency in going astern would be diminished, and turbine craft are already somewhat deficient in the matter of retrogression.

"Although, as stated, the Washington experiments have simplified the problem of selecting the propeller most appropriate to a given set of conditions, they have pretty conclusively demonstrated the hopelessness of any such improvement in the propeller as will permit of the ordinary reaction steam-turbine being applied to the driving direct of the propellers of the average tramp steamer. If the turbine is to come into general use for such craft, either some form of reduction gearing must be used, or some other form of turbine adopted. An analogous case is found in those water-power plants in which the quantity of water available is small, whilst the head is high. In such cases reaction turbines are never used, as the requisite speed of rotation becomes enormous, but some form or other of impulse turbine working with partial admission. With water such turbines have very high efficiencies; but partial admission in the case of a steam-turbine involves some serious losses, since the wheel has to run drowned. Nevertheless, it is perhaps on these lines that the application of the turbine to small-powered craft will ultimately be developed.

"At first sight the system of partial admission impulse turbines, velocity compounded on the Ferranti or Curtis system, would appear to possess great advantages for marine work in all cases. It is, however, impossible to use as narrow blades with velocity-compounded turbines as with the pressure-compounded type. With the former, provision has to be made for a very great increase in the radial depth of the belt of steam as it flows through the blades, and if the latter are very narrow, this radial expansion, which, it must be remembered, occurs without change of pressure, would be effected so abruptly as to lead to very large eddy losses. Here, no doubt, is to be found the reason for the failure, so far, of this type to show any saving over the Parsons marine pattern in the matter of the weight and length requisite to the attainment of a reasonable economy of steam. . . . . . For larger powers, therefore, we think the Parsons turbine will hold its own; but there does seem a possibility that a combination of the Curtis arrangement for the high-pressure end with the Parsons for the low-pressure might possess advantages in the case of the lower powered and relatively slower vessels. A very detailed study of the problem would, however, be necessary to definitely settle this, as in steam-turbine practice the aphorism that 'general reasoning is generally wrong' acquires an exceptional validity."

HEAT-TRANSMISSION LOSS IN SCALE-COVERED BOILER TUBES.

A SUMMARY OF THE CONCLUSIONS REACHED IN TESTS RECENTLY COMPLETED AT THE UNIVERSITY OF ILLINOIS.

Edward C. Schmidt—Western Railway Club.

THE serious lowering of the efficiency of locomotive boilers due to the formation of scale in the tubes and the consequent loss of heat transmission has led to a large number of investigations on the subject, with a view to determining, if possible, the relations existing between the conductivity and the thickness, hardness and other physical and chemical properties of the scale. One of the most important of these investigations was begun in 1898 in the department of railway engineering of the University of Illinois and a report of the first series of tests was published in 1901. It was felt at that time that additional data were required before general conclusions could be drawn and further series of experiments were undertaken in 1904 and 1905, the results of which are soon to be published as Bulletin No. 11 of the Engineering Experiment Station. A summary of this report was read by Prof. E. C. Schmidt at a recent meeting of the Western Railway Club and the following is an abstract of his paper.

"The tubes were removed from locomotives which had been in operation in various parts of the south and middle west. For each tube the thickness of scale was determined by calipering every 6 ins, of its length. The scale was examined and characterized as either hard, soft, or medium; and for each tube a chemical analysis was made of the scale.

"The apparatus in which the tubes were tested consisted essentially of a long water chamber, through which the tube to be tested was passed, and through which water was circulated. At one end of this water chamber was fastened a combustion chamber with which the tube communicated, and the heat delivered to the tube was supplied by the combustion of gas in this chamber. The heat abstracted from the tube was determined by weighing the water which passed around the tube and through the water chamber, and by noting its rise in temperature. For each series of tests the gas and air needed for combustion were delivered to the burner at constant pressure for all tests, and in approximately the same amounts.

"After adjusting the supply of water to the water chamber, the burner was lighted and the flow of gas and air regulated to the desired amounts. The apparatus was then allowed to run until all conditions had become stable. This usually required about one hour, at the end of which period the test was started. Observations were taken, at 5 or 10 minute intervals, of the temperature of the gases at entrance to the tube and at exit, as well as of the water temperature at entrance and exit of the water chamber. The amount of water used was determined by weighing. The purpose of the tests was to determine the number of thermal units transmitted per hour through each tube. This equals the weight of water circulated multiplied by its rise in temperature.

"When the experiments were planned it was considered probable that the transmission of heat through the scale was principally dependent upon two of its characteristics, namely, its thickness and its mechanical structure, and that probably, for such thicknesses as are usually met with, thickness had greater influence than structure. Thickness was therefore carefully determined and structure approximately designated as hard, soft or medium, no more exact characterization of structure being possible with tubes collected from different sources.

"It was hoped that the experiments might develop, if perhaps only approximately, some law of variation of conductivity with thickness. After making allowance for possible errors due to the method of conducting the tests, the result shows perhaps a decrease of conductivity with thickness; but certainly no regularity of variation. No regularity of variation is observable with respect to hardness or softness.

"It must be borne in mind that the tubes tested were taken from locomotives which had been in service in different parts of the country and that the scale on each tube was made up of the mineral constituents of many different water supplies. What was designated as hard scale in one case may be very different in structure (in porosity, for example) from that designated as hard scale on another tube. The results cannot therefore be considered as providing conclusive evidence concerning variation of conductivity with structure. They may properly be interpreted as indicating that mechanical structure is at least as important a factor in the change in heat transmission due to scale as is the mere thickness. Such a conclusion is, of course, in accord with the facts concerning other heat insulators."

It seeems probable that soft, porous scale would more effectively retain against the tube surface a layer of water or vapor of low conducting power, and we should accept with caution the assumption that hard scale will cause a greater loss than soft scale. The diagrams in which the loss in heat transmission is plotted with reference to the principal chemical constituents of the scale, do not warrant the conclusion that its chemical composition has any direct influence on its conductivity.

"Conclusion.—In so far as generalization is warranted we may sum up the results of the tests in the following conclusions:

1. Considering scale of ordinary thickness (say varying up to ⅛-in.) the loss in heat transmission due to scale may vary in individual cases from insignificant amounts to as much as 10 or 12 per cent.

2. The loss increases somewhat with the thickness of the scale.

3. The mechanical structure of the scale is of as much or more importance than the thickness in producing this loss.

4. Chemical composition, except in so far as it affects the structure of the scale, has no direct influence on its heat transmitting qualities."

NATIONALISATION OF RAILWAYS IN FRANCE.

THE SIGNIFICANCE OF THE RECENT PURCHASE BY THE GOVERNMENT OF THE WESTERN RAILWAY OF FRANCE.

Engineering.

GOVERNMENT ownership of railways, which is being so strongly advocated in both England and the United States at the present time, has been for many years the principal and most convenient plank in the platform of the French Socialist party. It has been urged repeatedly that the working of the railways by the companies forms a costly luxury, paid for by the people indirectly, and resulting directly in the application of high rates for carriage and transport, whereas State ownership would yield immediately numerous advantages and lower tariffs. French railroads have never been independent of the State but have operated their lines under a leasing system. State subsidies were secured for construction and State aid in the form of loans was granted them until they were able to meet their obligations out of their profits. The government-ownership party declared at the time this system was introduced that the railroads would never be able to pay back the loans but would forever remain debtors of the government and they advocated the purchase outright of all the French railways by the State. Time has not fulfilled their predictions. The railroads have been gradually increasing their strength and reducing their obligations to the government and the recent purchase of the Western Railway of France was consummated through the endeavors of the socialist party to prevent the removal of their last argument in favor of government ownership. The following review of the railway situation in France is taken from a recent number of *Engineering*.

"The leases granted to the railway companies in France are not perpetual leases. At the commencement, in 1842, they were very short; later on they were increased to 99 years; and now, owing to modifications which have been carried out in the distribution throughout the country of the various networks, the leases of the six companies working the larger systems are to terminate between 1958 and 1960. By the leases in question the State grants to the companies the working of the lines; the State bears the cost of the necessary road-bed, the companies having to take charge of the superstructure and of all the subsequent improvements and alterations required by development in the traffic. But among the concessions granted, many were for lines which were not likely to become paying lines for several years; the companies had, therefore, to face a financial crisis, owing to their heavy outlays. The Government helped them in this crisis by giving guarantees of interest, or, in other words, by lending to the companies a sufficient annual amount to cover interest and provide for repayment of loans. These State aids were in the shape of loans bearing interest, to be refunded when the profits of working exceeded the amount guaranteed; the State further was to share in the profits after collection of its debts, when the dividend exceeded a given percentage. In 1883, after having leased to the companies a number of new lines, or, more accurately, after having compelled them to build a number of non-paying lines, a very large programme of public works was started absolutely out of proportion with the State resources and with the results which might be expected from it. The object was to build harbours and ports at numerous places round the coast, canals in every direction, and new lines in sufficient number to satisfy even the most exacting voter. In the matter of railways, in particular, the State had then the ownership of a number of isolated lines which it had built and hardly knew how to work profitably; further, it was at a loss to find the necessary funds to build the new lines promised right and left—lines costly to build, and without any immediate future whatever. The State promises had to be kept; for this assistance had to be found, and the companies were therefore requested by the State to take charge of the non-paying lines in question, and to connect them up to their systems by other non-paying branch lines. The railway companies at that time were becoming firmly established on good financial bases, and were commencing the repayment of their loans and guarantees of interest above alluded to, except in the case of the Western of France Railway, whose system is, no doubt, less profitable than the others.

"This led to what is called in the French railway world the 'Conventions of 1883,' which conventions, the Socialist and monopolist *députés* assert, were entered into for the sole benefit of the companies, whereas, in truth, they were attended both by advantages and disadvantages, which, it was hoped, would balance each other within a comparatively short period, and finally result in benefiting the whole country. At all events, these Conventions had the effect of solving a difficult financial problem for the Treasury. The Conventions, of course, meant the conclusion with the companies of a new contract ensuring further State guarantees of interest applicable to the working of the indifferent lines to be taken over and connected up, but they also meant that the companies had to lay out large sums for construction purposes; the companies helped the State by undertaking, under compulsion, what the State was unable to take in hand for the time being. For this the companies issued loans in their own names, the State giving its guarantee in the usual way; but the guarantee under the conventions of 1883 has always been held separate from that given previous to the conventions. When the latter were entered into, there were good reasons to believe that State aid to the railways would soon become unnecessary; the date on which the companies would have paid off their debts to the State was also in view, and from that date the State was to commence receiving, when the railway profits exceeded a given sum, two-thirds of the amount in excess.

"Immediately after signing the Conventions of 1883, the country had to face an industrial and agricultural crisis, the effect of which was largely to reduce traffic. The net profit of the railway companies became insufficient to pay the guaranteed interest, owing to the fresh outlays they had to face by reason of the new lines that were forced upon their systems. The companies were compelled to have recourse for a long period, and for heavy sums, to the guarantee of interest granted by the State. Members opposed to the Conventions, and to the private working of the railways, concluded therefrom that the Conventions would never yield a satisfactory result. Gradually, however, and while the monopolists were publishing their adverse opinion, the situation was improving steadily, the companies were making less demands upon State aid, and were reaching the refunding period. The Western of France Railway alone still requires State aid to compensate for the insufficiency of its net receipts. But the situation as regards this company is also improving in a natural way, and it may be assumed that it would soon reach the favourable status of the other companies. This favourable status would continue for all, the State sharing the profits until the whole of the systems became State property on expiry of the leases.

"Among the most militant exponents of State enterprise in this respect may be mentioned M. Pelletan, whose policy as Minister of Marine was fraught with such evil consequences for the French Navy, and other *députés* who have argued throughout the land that the companies would never be able to reduce their liability to the State and to the rate-payers; but would, on the contrary, increase it year by year. A few years ago M. Pelletan, and those members who hold his opinions, asserted that all the French railway systems, with the exception of the Northern of France, were bound to remain forever debtors of the Budget, and they advocated the purchase by the State of the whole. As time went by, facts have contradicted their assertions, and they have been obliged to curtail their proposed programme, and to claim the redemption of only part of the systems, those which, to their showing, would never improve their status. But their later prophecies also have not come true, and the members in favour of State monopolies have hastened to obtain from the Lower House a vote providing for the nationalisation of the Western system, because this system was on the point of entering on a more satisfactory phase, thus destroying totally the arguments in favour of State enterprise. Formerly M. Pelletan advocated, with much emphasis, the redemption by the State of all the railways, except the Northern of France; later, in 1900, the Western, Southern, Eastern, and Orléans were alone on the tapis; in 1902 there remained but the Southern and Western; finally, in 1905, the Western alone was in question, because, in the case of the Southern, matters have improved sufficiently to quash all arguments in favour of State working.

"A fact which the monopolists willingly ignore is that State assistance has not been promised to the companies up to the time the leases expire, but only up to twenty-five years before their expiration. The debt of the companies to the State would at all events cease to increase twenty-five years before the expiry of the leases, were the companies unable then to commence reducing it. But, as we have stated, the companies have commenced refunding to the State the money lent them by the State as guarantee of interest. In 1904 the Eastern of France and the Paris Orléans Railway repaid the State 3,000,000 francs (120,000*l.*) each; repayment by the other debtor companies still goes on regularly. The Western of France Railway still borrows State subsidies, and in the case of this company the receipts are on the increase, and repayment to the State would soon commence. The latter is what the monopolists want to forestall.

"If the purchase of the Western Company is completed, it will not be possible to prevent the shareholders from reaping the advantages they have a right to by reason of the Conventions of 1883, and in exchange for the services they have rendered to the State Treasury. These Conventions contained conditions advantageous to the State, and others profitable to the companies, who became in a sense bankers to the State. If the State wishes to acquire the system before the natural expiration of the lease, it has to pay annually until the end of the lease (and not until the date on which its guarantee terminates) a sum equal to the revenue which the State deprives the company of, and corresponding to the average of net receipts, based upon a mutual agreement. But this sum must be, at least, equal to the revenue guaranteed by the State. Therefore, if the company could show receipts high enough to exceed what the State had guaranteed as minimum profit, the Treasury would have to pay the company, until the expiry of the lease, a sum exceeding that which the State lent when the company was not in a very favourable situation. It is true that in these circumstances the State would be working the system, and would collect the receipts, but experience in the matter of State control of railways tends to show that the receipts in such an event would be less than those of a company, even were the latter badly managed.

"By purchasing the Western, or the whole of the railways now, the French Government would pay dearly for the right of acquiring immediately a property which is to revert free to it later on."

A NEW ALPINE TUNNEL PROJECT.

DETAILS OF THE PROPOSED SPLÜGEN PASS RAILWAY BETWEEN SWITZERLAND AND ITALY.

Schweizerische Bauzeitung.

THE natural territorial boundaries between Italy and the countries lying to the north of it could be crossed formerly only by means of the passes or defiles over which "diligence" routes were maintained. But recent years have witnessed the completion of the Mt. Cenis, St. Gotthard and Simplon railway tunnels, and still the demand exists for more means of communication between Italy and Switzerland. It is very noticeable in this connection that a large and an increasing share of the traffic, both passenger and freight, traversing the existing Alpine tunnels is through or long-distance traffic, not only to and from the large cities of Switzerland, but also from the railway centers of Germany and Austria to all parts of Italy. To this steady, all-year traffic is added the enormous number of tourists that for three months in every year tax the railway facilities of these lines as well as those of most of the other European railways. It is, therefore, not surprising that a concession was granted a few months ago by the Swiss and the Italian governments for the construction of a railway from Chur, in the eastern part of the former country, to Chiavenna in the northern part of Italy. The project is not a new one, as several locations for such a line have been made within the past five or six years. That which seemed to have the greatest promise, though having to encounter steep grades, gives a short line of only 52 miles between the points named. A recent issue of *Schweizerische Bauzeitung* gives an account of this project, on which work is about to begin. The plan of the work and the credit of the location and surveys are due to Dr. Eduard Locher-Freuler, a Swiss engineer.

The line has been chosen, among other reasons, because it will afford the shortest route between the cities of northern Italy and the Engadine, Tyrol and Vienna, as well as the central and southern part of Switzerland. Beginning at Chur, the railway will parallel for a short distance the lately completed Rhaetian railway, then run in a southerly direction through Rothenbrunnen, Thusis and Andeer. At the latter place a tunnel will begin, carrying the line under the well-known Splügen pass, from which the railway takes its name, into Italian territory and on to Chiavenna, where it will connect with the existing railways to Milan, Venice and Genoa. The northern end of the line, from Chur to Rothenbrunnen, will be operated by steam locomotives, although there are two short but steep grades, 7 and 10 per cent. For the remainder of the distance, about 42½ miles, electric motors will be required, the steep grades and the long tunnel precluding the use of steam locomotives. A short distance south of Rothenbrunnen a steep ascent begins, the ruling grade being 26 per cent., and the line is carried constantly higher until Andeer station is reached at a height of 3273 feet above sea level, and 1344 feet higher than Chur, a rise of 1393 feet in 22 miles. At Andeer a tunnel 16¼ miles in length will be run through the Alps, and about half of this will be on an 18.5 per cent. grade against the north-bound trains. The tunnel will have only one track, but there will be two passing sidings, each 1640 feet long. From Andeer south there will be a 3 per cent. grade for four miles, at the summit of which the international boundary will be crossed, after which the steep descent begins into Italian territory. From Callivaggio, at the south portal of the tunnel, the grade will be almost entirely descending at from 23 to 26 per cent. until the terminus is reached at Chiavenna. As the south, or Italian, portal is about 650 feet lower than the north end of the tunnel, it is expected that there will always be a strong air current through the tunnel which will provide natural ventilation and at the same time, being unusually dry and having a high capacity for moisture owing to its high temperature, the air will maintain the rails in a sufficiently dry condition to afford the necessary tractive adhesion of the wheels. This result could not be obtained if the same grade were attempted from the north end, because the rails in the tunnel would always be wet.

The project is certainly bold, in spite of present-day attainments in engineering, and it will furnish enough problems to the designers and builders of the electric locomotives to class it as out of the ordinary. The estimated cost seems appalling, $24,841,000—for 52 miles, or at the rate of $477,000 per mile. This, however, means a completed railway, stations, permanent way, rolling stock and signals; and taking into consideration the character of the undertaking and the quality of all work done by European engineers, it is probably a very fair estimate. It is stated that ample power for the operation of this railway has been secured at sites on certain streams on the Swiss side of the Alps, in addition to which, as a reserve, it is probable that a plant will be established near Chiavenna, in the vicinity of the south end of the tunnel. While no definite announcement as to the kind of electric system to be used has been made as yet, the trend of European practice for heavy railway work is strongly in the direction of the three-phase alternating current; and it will not be surprising if this is adopted in this new project.

GYROSCOPIC STEADYING APPARATUS.

TESTS OF THE EFFICIENCY OF THE GYROSCOPIC ACTION OF A ROTATING FLY-WHEEL IN CHECKING THE ROLLING OF SHIPS.

Sir William H. White—Institution of Naval Architects.

SOME months ago a review in these columns discussed the gyroscopic apparatus for the steadying of ships, designed by Dr. Otto Schlick and explained the theory on which the design was based. At that time investigations had been carried out only on small models, but recently a highly important and successful series of tests was concluded on a ship of fairly large size on which Dr. Schlick's apparatus had been installed. At the request of Dr. Schlick, the results of the tests were communicated to the Institution of Naval Architects by Sir William H. White, who was an eye-witness of the experiments, and the following extracts are taken from a paper read by the latter at a recent meeting of the Institution.

The vessel on which the tests were carried out was the See-bar, formerly a first-class torpedo boat of the German navy, of which the principal dimensions are as follows:

Length at the water-line	116 ft.
Extreme breadth	11.7 ft.
Mean draught	3.4 ft.
Displacement	52.2 tons.
Metacentric height	1.643 ft.
Period of oscillation (double roll, with gyroscope at rest)	4.136 secs.

The gyroscope was placed in a compartment immediately forward of the boiler-room. As no electric power was available, steam was used and the flywheel was worked as a turbine, the periphery being provided with rings of blades and the whole being enclosed in a steam-tight, cast-iron casing. In order to minimise practical difficulties which might occur in carrying out the experiments, it was decided to keep the speed of revolution of the wheel relatively small, and to make its diameter correspondingly large. The following dimensions were finally adopted:

Outside diameter of fly-wheel.....1 metre.
Weight (without spindle).........1,106 lb.
Peripheral velocity per second.....274.8 ft.
Revolutions per minute..............1,600.

"The fly-wheel was made of forged steel in one piece. The cast-iron casing containing the wheel is carried on two hollow horizontal trunnions, their axis lying athwartships. These trunnions have ball-bearings. The steam supply and discharge take place through the trunnions in the same manner as in an oscillating marine engine. The lower end of the spindle of the fly-wheel is carried on ball bearings, and there is forced lubrication to both upper and lower bearings. At the upper end of the spindle a centrifugal regulator is fitted, by means of which the steam supply is cut off if the revolutions per minute exceed 1,600. In addition there is an appliance by which a bell is rung after every 10 revolutions of the fly-wheel, in order that the engineer may readily check the rate of revolution.

"The common centre of gravity of the gyroscopic apparatus—fly-wheel and casing—is arranged to lie below the axis of the trunnions. When the vessel is at rest, in an upright position, the spindle of the fly-wheel will be vertical. When the vessel is set rolling, the spindle of the fly-wheel is free to become inclined to the vertical in a fore-and-aft direction. As rolling proceeds the gyroscopic effect of the fly-wheel produces longitudinal oscillations of the apparatus. The period of these oscillations depends, of course, upon the distance of the centre of gravity of the whole apparatus below the axis of the trunnions, and upon the moment of inertia of the apparatus about that axis. The amplitude of oscillation of the gyroscope depends upon many and varying conditions, amongst which the period of oscillation and its ratio to the period of rolling of the vessel are important. It is most interesting to watch the movements of the gyroscope, when it has been set free and is exercising a steadying effect upon the vessel. The observer may be standing upon a deck that maintains a practically horizontal position as the vessel performs vertical heaving oscillations; but the gyroscope meantime may be oscillating violently to and fro in the longitudinal sense, and the observer watching it may have the impression that the vessel herself is moving.

"It will be understood that great importance attaches to the existence of efficient arrangements for controlling and 'braking' the movements of the gyroscope on its trunnions, and the rotary movement of the fly-wheel. In the See-bar this matter has been carefully studied, and experiment has shown that the brake arrangements are thoroughly efficient. A simple band-brake is fitted on the port side, and is worked from the deck above, in order to control the swinging motion of the apparatus on the trunnions, or to hold it at rest. In addition there is a socket fixed on each side of the gyroscope-casing below the fly-wheel, which carries an hydraulic brake-cylinder, the piston-rod lying fore-and-aft in the vessel. The braking-power is regulated by a valve workable in the gyroscope compartment, and from the deck. This hydraulic brake answered its purpose well, but in electrically-driven gyroscopes a different design would be adopted, involving less space and weight.

"When the apparatus was used in experiments at sea, the fly-wheel was set running while the casing was held fast by the friction-brake in its central vertical position, and the revolutions were brought up to 1,600 per minute. Observations were made at first with the casing fixed; in which condition, of course, the gyroscope had no effect on the rolling motion. After a sufficiently long period of observation in this condition had elapsed to enable the 'phases' of rolling to be determined, the friction-band was loosened, the casing began to oscillate on its athwartship trunnions, and the gyroscopic action came into play. Another series of observations of rolling was then made, and the steadying effect of the gyroscope was ascertained by comparing the two series of observations."

Before making any experiments on the steadying effect of the apparatus, the working of the gyroscope was tested with the ship still at her moorings. The apparatus was found to work satisfactorily, no shock or vibration was observable, the arrangements for braking proved efficient, and the fly-wheel was speeded up to 3,000 revolutions per minute without any bad effects. Still-water rolling experiments were undertaken next, the motion being produced by running the crew from side to side of the deck. With the gyroscope fixed, the period of a complete double roll was found to be 4.136 seconds. When the fly-wheel was running at 1,600 revolutions per minute the corresponding period of oscillation was found to be 6 seconds—an increase of 45 per cent. Owing to the small size of the deck, only small angles of heel were attained by this method of producing motion and greater angles of inclination were produced by heaving the boat over by means of a chain from a crane, made fast at one side of the boat and fitted with a slip-hook. At inclinations of from 10 to 15 degrees from the vertical, the chain was suddenly let go and successive extreme inclinations were noted until they fell to about 0.5 degree. These experiments strikingly illustrated the enormous extinctive effects of the gyroscope. For example, with an initial angle of inclination of 10 degrees, 20 single oscillations took place before the extreme inclination to the vertical was reduced to half a degree, the gyroscope remaining at rest; while the same amount of extinction was obtained with little more than two single oscillations when the gyroscope was free to oscillate and the fly-wheel was running at 1,600 revolutions per minute. In another case, when the initial angle was 13 deg. 40 min., 25 single oscillations were required to limit the inclination to half a degree from the vertical when the gyroscope was at rest, but only three when the gyroscope was free and the fly-wheel running at 1,600 revolutions.

Experiments undertaken in the sea-way were fully as conclusive. Considerable difficulty was experienced in obtaining a sufficiently rough sea in which to make the tests, but on two days on which conditions were favorable, excellent results were obtained. In all cases the practical effect of the gyroscope was to extinguish the rolling motion almost immediately. With the gyroscope free to oscillate and with a rotation of 1,600 revolutions per minute, the See-bar was practically deprived of rolling motion and simply subjected to heaving motion as successive waves passed her as she lay broadside on to the sea. One set of observations gave maximum inclination on each side of the vertical with gyroscope fixed, 15 degrees; arc of rolling, 30 degrees; with gyroscope oscillating the arc was reduced to one degree within a very short time.

"The gyroscope fitted in the See-bar was intentionally made relatively powerful for purposes of experimental illustration. The proportion of the weight of the fly-wheel in that case to the total weight of the See-bar was as 1 to 114. The proportion of the moment of inertia of the fly-wheel to the moment of inertia of the whole boat about a horizontal longitudinal axis passing through the centre of gravity was approximately as 1 to 1,156. In order to obtain experimental data which should be of value in further designs of gyroscopes, it was decided to make an experiment with the See-bar with the fly-wheel running at less rates of revolution than 1,600 per minute. When the revolutions were reduced to 1,200 no sensible difference was observed in the steadying effect; at 1,000 revolutions per minute, a slight reduction in the steadying effect was remarked. At 800 revolutions, under conditions when inclinations of 12 deg. on each side of the vertical were observed with the *gyroscope fixed,* rolling was reduced to 3 deg. on each side of the vertical when the gyroscope was free to oscillate. This last trial showed that when the moment of inertia of the fly-wheel was only *one-fourth* of that provided for in the design of the gyroscope of the See-bar, a considerable reduction in rolling was produced. It has been stated above that the number of revolutions of the gyroscope fitted in the See-bar were raised to 3,000 per minute in the preliminary trials, and that no bad results followed. Experience with the wheels of steam turbines also shows that it is possible to work at much higher peripheral velocities, provided suitable designs and materials are adopted. With a peripheral velocity twice as great as that used on the

See-bar, the same effect could be obtained with a fly-wheel of 2.3 ft. diameter as was obtained when the actual fly-wheel fitted ran at 1,600 revolutions per minute; and it is evident from the trials made at reduced rates of revolution that a wheel of only 2 ft. in diameter would have given as great a steadying power as was required in practice. These facts are of great importance in considering possible applications of the system to larger vessels. Such installations would include electric driving as well as improvements in lubrication and in the design of the brakes. Dr. Schlick has already done much work in these directions; he is convinced that the system may be applied to larger vessels in forms that would secure considerable steadying power; while the requirements for weight, space and motive power would be kept within such moderate limits that they could be accepted by shipowners."

The experiments indicate great possibilities for the system, but Sir William considers that it will be wise to proceed gradually. In modern steam yachts and small coasting steamers, gyroscopic apparatus could be installed with no inconvenience and with excellent results. In ocean-going passenger steamers the advantage would not be so marked as this class of vessels are remarkably steady at sea on account of their large size. In war-ships, however, the advantages would be numerous and we may expect to see the device applied to destroyers and cruisers in the near future as the tendency in design is to obtain the greatest possible stability and steadiness for these vessels, especially to secure steady gun platforms.

RAIL CORRUGATION.

A DISCUSSION OF THE INFLUENCE OF DEFECTIVE ROLLING STOCK IN CAUSING CORRUGATION OF TRAMWAY RAILS.

Joseph A. Panton—Institution of Electrical Engineers.

THE question of the corrugation of tramway rails is one of the most perplexing with which the traction engineer has to deal. Though the subject has been discussed at great length and on many occasions, no adequate theory as to the cause of the trouble has been evolved and there are almost as many different opinions on the subject as there are tramway officials.

Unsuitable rail material, chemical action upon rails, fatigue of rails due to excessive loading, slipping of braked wheels, are a few of the theories which have been offered in explanation of the phenomenon, only to be rejected as being applicable to but a limited number of cases. In a paper read at a recent meeting of the Institution of Electrical Engineers, Mr. Joseph A. Panton advances the theory that the trouble is due entirely to defective trucks and an outline of his argument is given in the following abstract.

"Seeing that the actual corrugations occur on the rail, it is but natural to suppose that their presence or absence depends on the quality of the rail. The author has come to the conclusion that no satisfactory evidence has yet been put forward in support of this view. In fact, enough evidence has now accumulated to contradict any rail theory that might be promulgated. The following, amongst others, are reasons why the rail theory fails to account for the presence of corrugation:—

1. Because rails manufactured by every firm in the world have corrugated since the advent of electric traction.

2. That the rails did not corrugate in the days of horse and steam cars.

3. That the check rails are corrugated to an equal degree, and parallel to that on the crown of the rail.

4. That rails did not corrugate so long as the armatures were built on the axle.

5. That it takes on the average three years to develop corrugations on a new system, and only three weeks on relaying with new rails thereafter.

6. That an ordinary railway rail taken from the straight road of an electrically-operated railway (where no corrugations occur), and relaid on a checked curve soon corrugates.

"Further, corrugated rails have been

tested, and found to contain all the chemical constituents, and to possess the physical qualities required of them. It has been said that the trouble is due to the chattering of the rollers at the rolling mills, owing to play in the pinions and bearings of the rolls driven by antiquated steam engines. For the sake of argument, assume this to be so. Why, then, is it that the rails on electrically-operated railways only corrugate on checked curves, the remaining seven-eighths of the track being perfect? And why does it take so long to corrugate tramway rails on a new system, and so short a time on renewals? And why are not corrugations found on our steam railroads, running at 60 miles per hour? Further, in this country and abroad we find corrugations 24 inches to 30 inches in wave length. If chattering is going on in the Middlesbrough rolls on so gigantic a scale, the noise of it should be audible for miles around.

"The author's attention was first drawn to defects in rolling stock as a means whereby corrugation might be caused, by the action of a flanged brake block then being tried to keep down wheel flanges. The tendency of the flanged brake blocks was to cut into the outer edge of the wheel tire, and it appeared difficult to account for this peculiar action. Later on it occurred to the author that the bogie truck frame and the wheels were not acting in unison, especially when rounding sharp curves. The bogie-truck frame, by means of the hangers, communicated to the brake block a twisting movement, which caused it to cut the wheel tread. On reverting to the brake block without a flange no cutting occurred, but by judicious watching it soon became apparent that this block had a decided tendency to run off the wheel tread on one side, and cut into the flange on the other. On further examination, it was found that the frames were out of square and the axles out of line; this was due probably to the axle being geared at one end of the shaft only, the tendency being to form diamond-shaped truck frames. To prove this remarkable result of defective gearing, the author has only to draw attention to the case of the Liverpool Overhead Railway during the first nine or ten years of its existence, when the armatures were built on the axle, whereby a symmetrical drive was obtained. During this period, there was no sign of any corrugations. On introducing single-ended geared axles into the same bogies, a series of difficulties cropped up when running over the same rails, necessitating the renewal of rails on checked curves.

"Many similar cases have occurred on tramway undertakings where the conversion from steam to electric traction over the same rails has brought about corrugation. Being geared at one end and mounted in a weak truck frame, the whole tendency is to push the frame out of square, and the axles out of line, and as an examination of the wheel tires clearly indicates, a grinding action takes place between the wheel flanges and guard rails. The wheels soon become groove-locked when speed is attained, and the wheel flanges striking the check rail intermittently cause the whole axle to jump or oscillate in the groove, giving rise to intermittent skidding and producing the peculiar flattening of the rail, known as corrugation. Corrugations will also be found on the check rail, equal and parallel to those on the crown of the rail, which clearly demonstrates that the wheels oscillate in the groove. This soon brings about unequal tires on the same axle, which causes a momentary slowing or lagging behind of one tire, and this still further increases the tendency to locking of wheel tires, as can readily be seen by the severe indentations on the check rail, each indentation tapering off to nothing as the tire is freed. Immediately the tire is freed it jumps forward the required distance to bring it into line, producing a sort of case-hardening effect on the head of the rail which remains high, and as it is at the same time revolving, in doing so it scoops or grinds intermittent hollows in the rails, the wave lengths being determined by the speed of the car and elasticity of the track. In the matter of wheels we have clung to old practices longer than might have been expected, having made few changes in their dimensions or contour, a matter which requires immediate attention; for as we have considerably increased the speed and weight of cars, the tread and wheel flanges ought to be suitably modified to adapt them to the new conditions. Again, the running of a ¾-inch thick flange in a 1-inch wide groove requires further consideration, especially when rounding curves.

"A large percentage of the trucks under our street cars are not capable of meeting modern requirements, because of the inability of the frames to withstand side strains. Such trucks may be cheap at the beginning, but constantly require repair, while at the same time they need more current to draw them, and are most expensive in the end. The present-day bogie-truck frames of rivetted and built-up construction, as used by most electric railway companies, carry the load in the centre, and are themselves supported upon equalising springs instead of on journal springs. This gives a short spring base for the frame, and in consequence, when the brakes are applied, the frame is pulled down at one end and pushed up at the other. The author has noticed frames tilting 3 or 4 in., bringing the life-guards down on the rail.

"The equalising bar bears directly upon the axle box, and when the horn slides are worn the boxes take up a rigid position at an acute angle to the jaws of the frame causing a binding of the boxes, and producing the vibration so noticeable in trucks of this design. It is, therefore, necessary to give up the riveted and built-up construction of bogie frames on modern high-speed electric railways. It is the weakness in bracing the two sides together, especially under the axle box, that makes the present-day trucks unable to withstand the severe side strain they are subject to. It will, therefore, be necessary to supplement the present trucks with suitable under-frames well braced on either side of the wheels. In the author's opinion, the time is not far distant when we shall have brake blocks on either side of the wheel, especially for street traction. The difficulty with horn slides would then be obviated. Some careful observations have been made with reference to the effects of retardation on the rails. With heavy electric trains running at 40 to 60 miles per hour, only barely visible wavy skin depressions appeared on the rails after a hard application of the brakes, the depressions being distorted and finally obliterated by the next train. Sudden braking operates unfavourably on the superstructure, in the sense that the rails are subjected to vibration, and consequently the sub-structure gets separated, but this action has gone on for years at the same place without creating any impression upon the head of the rail. There is, therefore, no ground for assuming that the application of brakes has any connection with corrugations or roaring rails."

HARDENING ROADS BY SURFACE APPLICATIONS.

A REVIEW OF THE METHODS USED TO REDUCE DUST ON HIGHWAYS CARRYING HEAVY TRAFFIC.

J. W. Howard—American Road Makers' Association.

THE suppression of the dust of roads has become a necessity from both a hygienic and an economic standpoint. Flying dust carries disease germs which are a constant menace to the public health, and it works incalculable damage to food products in transit, to crops, to real estate values, besides entailing a constant loss of road material. The road dust problem is, therefore, receiving a great deal of attention from engineers in all civilized countries. At a recent meeting of the American Road Makers' Association, Mr. J. W. Howard outlined the various methods which are used for hardening roads by surface applications, and the following abstracts are taken from his paper.

"The following are the general methods in use for reducing dust. Each method more or less retains or agglomerates the dust already formed or prevents its formation:

1. Sprinkling roads with fresh water.
2. Sprinkling roads with natural salt water.
3. Sprinkling roads with mixtures of water and calcium chloride.
4. Sprinkling roads with mixture of water and saponified oil.
5. Impregnating roads with special crude oils.
6. Impregnating road surfaces with special coal tar products"

Sprinkling with water is at best only a

temporary help, and, besides being impossible on thousands of miles of roads, when done continuously on short stretches it costs more than any of the other methods. Salt water is, of course, available only near the ocean. Its use gives rather better results than that of fresh water, because the salt accumulates on the road and absorbs moisture. When dry, however, the salt hurts the throat and eyes, damages clothing and furniture, and has rather serious effects on the feet of horses.

Sprinkling with a solution of calcium chloride is related to sprinkling with salt water, both methods being based on the principle of a hygroscopic salt. To produce the best results on macadam roads, about three pounds of the salt are required per gallon of water. In one case, good results were obtained by sprinkling three times the first month and twice each subsequent month at a total cost of about 10 cents per square yard. The calcium method is a temporary help at a few places, but it is expensive and out of the question for general use. The saponified oil method is used in Europe to a certain extent and there are several patented compounds on the market for this class of work. But all these soapy compounds are of doubtful value for use in America where substances which are durable and require attention only at long intervals must be used.

"The application of certain oils to roads practically began in California in 1894, when crude-oil from the Summerland oil wells was used on the Ortaga Road five miles from Santa Barbara. It was sprinkled to lay the dust of the soft soil of the road. A slight hardening of the road was observed from the repeated applications of the thick maltha or asphaltic oil. A few other roads in California were sprinkled until about 1900, when the use of its oils on roads rapidly extended from the many oil centers in that state, until to-day, oil is used for suppressing dust and hardening roads, with varying success and failure, in about 40 counties of California to an extent of a little more than 2,056 miles. * * * * * *

"Probably the best constructed and maintained oiled road of California is the driveway of Golden Gate Park near San Francisco. The oil when cold is between 14 and 16 degrees Beaume. It was heated to about 300 degrees F.; sprinkled while hot on the road; men followed closely and stirred the oil into the road with rakes. The road of course was first properly graded and shaped. Its surface was made smooth, then soaked with water to loosen it. It was next well dried to a depth of at least 1 inch and the oil applied as stated during warm dry weather. Repairs are constantly made by promptly sweeping out any little hole that forms, putting in a little oil, adding gravel and stone dust to absorb the oil and tamping until firm. The oil costs 72 cents per barrel and 400 barrels per mile of 16-foot road were first applied. Since then 300 barrels per mile have been applied twice each year or 600 barrels per year. The tendency is to form into ruts and a slight lowering of the whole road surface. This last is caused by rain water working through the surface and carrying away the road material from under the asphaltic oil crust. Although expensive, it is so important a drive out of San Francisco that it is worth all its costs. * * * * * *

"Road materials, which if wet, would pack firmly under roller or traffic and still remain slightly porous, are the materials which are the best for use by saturating with suitable thick adhesive oils. Such oils suppress dust and harden such a road. Road materials of certain clays, earths and gravels which, when wet, pack tight or bake in the sun and which pulverize into dust, must be either loosened up by harrowing or otherwise made porous before being oiled, and then must be covered with sand, screenings or the material of the road. Oiling roads is a case where a little knowledge is dangerous, and where much knowledge and experience must be employed to select suitable oils and to use them correctly. * * * * * *

"The use of coal tar and its products as ingredients of pavements and roads has been undertaken in many ways for about fifty years, but with no success until quite recently. The tarring of a macadam road means sprinkling, painting or covering its surface with a soft tar specially prepared for that purpose, and which will penetrate the macadam and make it waterproof and retard the formation of mud and dust. A prepared tar which is sufficiently fluid to lay dust and penetrate the surface of the macadam cannot be a binding material to hold together any portion of that macadam except the finest particles and dust.

"Specially prepared coal tar, by surface application on macadam to eliminate dust and make the macadam waterproof and more durable, first succeeded in Melbourne, Australia, in 1886, where the experience gained has been followed by constant use ever since. Tar freed from water and very light oil and otherwise improved is used. The macadam is first well bonded and consolidated, then tarred and fine stone screenings are spread. Coal tar products are suited to hard macadam and similar roads, because it is not practical and economical to use these products on soft earth, clay and sand roads. The cost would be too great, sufficient tar is not available, it would not harden. It is better and cheaper, where obtainable, to use suitable asphaltic oils on soft and absorbent roads. * * * * *

"The Vendee District, France, based on records begun in 1896, shows as follows: One highway 20 feet wide was tarred in the following manner: The macadam was put in good condition, well rolled and used by traffic for a month; then thoroughly cleaned by stiff brooms, followed by fine brooms. Hot tar was spread over the macadam. It percolated down into the macadam, the work being done in warm weather with the road very dry. It penetrated 1 inch in four hours, and 1⅔ inches in twenty-four hours. The first tarring required about 1.9 pounds per square yard. Twelve hours after tarring each section, clean sand was spread. The surface was then rolled and opened to traffic.

"One year later the operation was repeated, using less tar, because the road would absorb less; then every second year thereafter. The road was practically free from dust, its wear was reduced to about one-half and the total cost of the road in ten years was 40.4 per cent less than under the old system of maintaining the road in constant good condition with macadam only. This was due principally to the fact that the tar saved $1,430, which would have been paid out during the ten years for extra crushed stone and resurfacing, if the surface had not been tarred at intervals as stated. Tarring made it necessary to resurface with stone only once, not twice, as formerly. A second road in the same district properly tarred costs 23 per cent less on a basis of fourteen consecutive years than if it had been maintained with macadam only. * * * * * *

"The work should be done only in warm, hot and dry weather. The macadam should be first swept clean and sometimes washed, but should be allowed to become perfectly dry to a depth of at least 1 inch before applying the tar product. The tar should be spread uniformly under competent supervision. It should be allowed to stand and percolate for at least several hours after being spread and then be covered preferably with sand or with uniform fine grained stone screenings, containing no earthy matter or dirt. The tar should be applied as hot as possible at about 200 degrees F. After the sand or screenings have been spread, it is best to wait several hours before rolling with a steam roller. During the rolling additional sand or screenings must be added if any tar squeezes up through them. It is a good plan to keep traffic off of the finished rolled road for a short time after rolling."

HYDRO-ELECTRIC POWER PLANTS IN EUROPE.

EXAMPLES OF RECENT HYDRO-ELECTRIC DEVELOPMENTS IN ITALY AND SWITZERLAND.

Schweizerische Bauzeitung.

THE series of articles on Hydro-Electric Power versus Steam, by H. von Schon, which began in THE ENGINEERING MAGAZINE for April last, reaches a most interesting stage elsewhere in this issue. There the distinguished author shows (pages 353-380) three typical modern installations on the American continent—one Canadian, one using the waters of the boundary between the Dominion and the United States, and one belonging to the new industrial South—which by their wide diversity of design demonstrate the great range of adaptiveness of this mode of power generation.

Mr. von Schon's tone, nevertheless, is

that of an advocate for a movement which is yet in its minority in the Western World. The list of undeveloped opportunities which he gives, taken at random from a collection of data many times as great and presented as an appendix to his article, shows that the great things already done are but the beginning of those yet possible in American industrial development. On the Continent of Europe, however, hydro-electric engineering has a longer start. The comparative dearness of fuel and the density of industrial and power-using population combined to turn attention early to the improvement of water powers and to the prompt utilization of every advance in electric generation and transmission. Many of the interesting steps in this progress, as shown by characteristic plants, have been followed by illustrated descriptions in this magazine. Each month, almost, brings fresh examples, and it is of interest to compare some of the most recent with those described or proposed by Mr. von Schon in his current article.

When long-distance electric-transmission lines became an accomplished fact, a great impetus was given to the utilization of waterfalls in Europe, especially in Switzerland and northern Italy where Alpine torrents are numerous and where the demand for power at the manufacturing centers appears to be slowly increasing. One of the streams rising in the Alps and flowing finally into the Gulf of Venice, is the Adige, or as the Germans call it, the Etsch river. Near the city of Verona, a power plant has just been built to supply electrical energy for lights and motors in the vicinity. At a sharp bend in the river near this city the bed is steep and broken by numerous rapids. Just at the beginning of the bend a canal has been built, forming a cut-off about 4900 feet long, diverting part of the water to the power house situated at a point lower down the river. As the river Etsch is subject to great changes of water level, the turbines in the power house are designed for operating under a normal head of 18 feet of water, and at the same time allowance is made for 18 feet variation in the stage of the river. Four turbines, each of 700 horse power, and two of 60 horse power each, are installed, the four main turbines operating the main generators and the two 60 horse-power units driving the direct-current exciters. The turbines were built by Escher, Wyss & Co., of Zurich, and the generators by Brown, Boveri & Co., of Baden. The generators supply three-phase alternating current at 10,000 volts, which is distributed without intermediate transformation to the various centers of distribution. A large textile mill uses about 800 horse power. The energy is stepped down from 10,000 to 500 volts, at which voltage it is distributed to the 69 motors that operate the various machines.

The turbines, with the rotor attached, are massive and set on solid masonry foundations. While as regards capacity, this station is not of unusual size, it is representative of many European plants, which as a rule, are of moderate size as compared with those now commonly built in the United States. Noticeable features in the Etsch installation are the permanent character of the works, the well-designed turbine house, built of stone, and the simple system of distribution. As the power is supplied over only moderate distances, the voltage, 10,000, is as high as is consistent with economy in first cost, and considering the troubles likely to ensue from the use of very high potentials in a damp climate. The regulation of the turbines is said to be excellent; it is accomplished by altering the position of the inlet gates leading to the turbines by means of a set of cylinders containing oil maintained at a pressure of from 70 to 75 pounds per square inch. The station is representative of many now found in Europe, where the available head of water is low, but where, by careful design, a sufficient quantity of water is secured to develop a moderate amount of energy. In this case the available quantity is about 3000 horse power, considered as a minimum the year round through all stages of the river.

In Switzerland every year witnesses some new installation wherein water from the mountain streams, hitherto running to waste, is made to perform some useful work. Recent developments in electric power transmission, pointing the way to the use of high-tension currents over long aerial lines, with the resultant possibilities of the centralization of power plants with the accompanying use of large power units, are having their effects in recent Swiss installations. A very interesting example of modern practice is found in a station in the northern part of Switzerland, located so as to take advantage of the fall of the river Aare, near Beznau. The Aare, for some distance before it meets the Rhine, flows in a northerly direction, and within a few miles of its mouth, has a fall of about 11 feet. To take advantage of this, a dam was built, and just above a canal was excavated to lead water to the power house situated farther down the river and just beyond a sharp curve. The canal is 3870 feet long, 138 feet wide at the bottom and 200 feet wide at the water surface when filled to a depth of 16 feet. It is constructed on a 15 per cent grade, and delivers the water to a large turbine station, which, in addition, shelters an auxiliary steam plant for use during periods of low water.

At normal stages of the river, this plant develops 14,000 horse power, which is transmitted by several lines to Zurich, Winterthur, Grüningen, Grynau, Leimbach, Entfelden and Rheinfelden at 25,000 volts, in addition to local circuits near the station to Beznau and vicinity. Most of these transmission lines are from 25 to 65 miles in length, and in the cities and towns just mentioned, the 25,000-volt current is transformed to 8,000 volts for distribution within the town limits.

Eleven turbines are installed at the power house, each rated at 1200 horse power, running at 66⅔ revolutions per minute under 11 feet head of water. In addition to these there are two 400 horse power turbines running at 85 revolutions per minute and driving the direct-current exciter dynamos. Owing to the great variation in the height of water in the river, amounting to about 13 feet, the turbines are built in two parts, the upper and lower being called respectively the high and the low water turbines. The former are built and located in such a manner as to develop the rated power with a large quantity of water under low head, while the low-water wheels pass less water through their blades, but receive it under higher pressure.

Each turbine drives a three-phase alternating-current generator which develops 1200 horse power at 8,000 volts and 50 periods per second. The speed regulation under changes of load is accomplished by a centrifugal governor which controls a valve admitting oil under high pressure to either end of a regulating cylinder, the piston of which imparts motion to rods and levers which move the vanes admitting water to the turbine. It is said that this governor is very sensitive to small changes of load, and holds the speed of the turbine and generator within small limits.

The two exciter machines generate 150-volt direct-current, and either one can take care of all the main generators at one time. There are also installed at this station seven transformers connected on the low-pressure side to the 8000-volt terminals of the generators, and delivering energy to the transmission lines at 27,000 volts. Besides these there are four step-down transformers, 8,000 to 250 volts, to supply local circuits for lights and motors in the station and in its immediate neighborhood.

To avoid any possible interruption of the service from low water or any other cause, an auxiliary steam-driven electric plant has been built which can produce 7,000 horse power, thus furnishing a reserve supply of about 60 per cent., as well as an overload capacity for emergencies. This steam station contains six Dürr watertube boilers, each of 3,767 square feet heating surface and having a superheater which delivers steam at 191 pounds per square inch pressure and superheated 350 degrees C. They are equipped with mechanical stokers and have two steel stacks, 49 feet high, fitted with Sturtevant blowers driven by electric motors. Steam is supplied to two Parsons turbines built by Brown, Boveri and Company, running at 1,500 revolutions per minute and driving the 8,000-volt three-phase generators. Every possible precaution seems to have been taken to insure the continuous operation of this plant and to make use of all power that was available in the immediate vicinity by building the intake canal very long, so as to secure the maximum fall of the river. It is certainly one of the best examples of up-to-date power development in Switzerland, if not in Europe.

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Bascule.

The Strauss Trunnion Bascule Bridge Near Rahway, N. J. Illustrated detailed description. 2800 w. Eng Rec—April 13, 1907. No. 83709.

Drawbridge.

A Center-Bearing Drawbridge with Pneumatic Raising Jack and Turning Engine. Translated from *Zeitschrift für Bauwesen.* Illustrated description of an interesting structure recently completed in the city of Hamburg, Germany. 2000 w. Eng News—April 4, 1907. No. 83452.

Maximum Loads.

Maximum Live-Load Bending Moments and Shears for Bridges Carrying Electric Cars. Calls attention to heavy construction cars, service and freight cars, that must at times pass over such bridges and makes a study of the maximum moments. 1500 w. Eng News—April 4, 1907. No. 83449.

Plate Girder.

Methods and Cost of Constructing a Plate Girder Railway Bridge with Concrete Piers. Illustrated description of a bridge in Oklahoma, with an account of the methods of work and the cost. 2000 w. Engng-Con—April 3, 1907. No. 83-472.

Detailed Cost of Erecting Three Plate Girder Bridges of Ten Spans. Data relating to the cost of erecting three plate girder bridges, on concrete abutments and piers, having pile foundations. 1000 w. Engng-Con—April 17, 1907. No. 83793.

The Warehouse Point Bridge of the New Haven R. R. Illustrated description of an interesting example of plate girder construction for heavy traffic at high speed, with an account of other bridges occupying this site. 1800 w. Eng Rec—April 27, 1907. No. 83945.

Reinforced Concrete.

Concrete Arches with Old Rail Reinforcement. C. L. Slocum. Portion of a paper before the Conn. Soc. of Engrs. Discusses this form of construction, describing the type of arch used for street crossings over the New Haven cut at New Haven, Conn. Ills. 3000 w. Eng News—April 11, 1907. No. 83564.

The Kishwaukee River Bridge of the Elgin & Belvidere Electric Co. Illustrates and describes the construction of a ribbed concrete-steel bridge of four spans. 1300 w. Ry & Eng Rev—April 13, 1907. No. 83728.

The Highway Bridge Near Goshen, Ohio. Illustrated description of a five-span, arched, reinforced concrete bridge, 16 ft. wide and 493.5 ft, long, and its construction. 1600 w. Eng Rec—March 30, 1907. No. 83366.

Reinforced Concrete Structures on the New Austrian State Railways (Der Eisenbetonbau bei den neuen, durch die k. k. Eisenbahnbaudirektion hergestellten Bahnlinien der Oesterreichischen Monarchie). August Nowak. Description of railway and highway bridges and details of their construction. Illus. Serial. Parts II and III. 2200 w. Beton und Eisen—Jan. and Feb., 1907. No. 83601 each F.

Replacement.

Replacement of Bridges and Allied Structures. Herman K. Higgins. Considers the classification, inspection and the determination of when replacement is necessary, and the loads allowable. General discussion. 9000 w. Jour Assn of Engng Socs—March, 1907. No. 83766 C.

Restoration.

The Auld Brig o' Ayr. An interesting account of restoration work to preserve this historic structure in Scotland. Ills. 3000 w. Engng—April 12, 1907. No. 83879 A.

Strengthening.

Strengthening Girder Bridges on the Madras Railway. Edward W. Stoney. Describes methods used in strengthening or renewing a large number of girders with as little interruption to traffic as possible. Ills. 2200 w. Engng—March 29, 1907. No. 83554 A.

Suspension.

The Monongahela River Suspension Bridge at Morgantown, W. Va. W. H. Boughton. A statement of the conditions found on a recent examination of this bridge, especially in regard to the cables. 1000 w. Eng News—April 18, 1907. No. 83894.

The Design of Cable Suspension Bridges with no Guys. (Calcul des Ponts Suspendus à Câble et sans Hauban.) A Paris. Mathematical discussion of a method for estimating the indeterminate stresses. Ill. 2300 w. Bull Tech Suisse Rom—March 25, 1907. No. 83699 D.

Viaducts.

The Sixth Street Viaduct at Kansas City. J. A. Lahmer. Illustrated detailed description of the viaduct extending from Sixth and Bluff streets in Kansas City, Mo., to Fourth street and Minnesota avenue in Kansas City, Kan. 2200 w. R R Gaz—April 12, 1907. No. 83575.

The Reinforced Concrete Viaduct of the Richmond & Chesapeake Bay Railway at Richmond. Illustrated description of a viaduct to carry a single-phase line for freight and passenger service, 2000 w. St Ry Jour—March 30, 1907. No. 83360.

CONSTRUCTION.

Bathhouse.

New Bathhouse of the City of Hanover. (Die neue Städtische Badeanstalt in Hannover.) E. Stack. Description of a large German bathing establishment, with details of construction, heat supply, etc. Ills. 4700 w. Gesundheits Ingenieur—March 2, 1907. No. 83641 D.

Buildings.

Structural Details in the Plaza Hotel, New York. Illustrates and describes interesting details in this 18-story, steel cage hotel, facing Central Park. 2200 w. Eng Rec—March 30, 1907. No. 83371.

Structural Details of the Holy Angels School, Buffalo. An example of reinforced concrete construction combined with brick and stone walls is illustrated and described. 2000 w. Eng Rec—April 20, 1907. No. 83835.

Providence Armory Drill Hall. Illustrates and describes the construction of a 235 x 170 ft. steel drill hall, 70 ft. in extreme height. 1800 w. Eng Rec—April 13, 1907. No. 83711.

Modern Steel Buildings. John M. Ewen. Read before the School of Prac. Science, Toronto. On modern steel-frame buildings and their construction. 3500 w. Can Archt—April, 1907. Serial. 1st part. No. 83971 C.

Concrete.

Forms for Concrete Construction. Sanford E. Thompson. Read before the Nat. Assn. of Cement Users. Treats of the design, construction and removal of forms. Ills. 3300 w. Sci Am Sup—April 27, 1907. No. 83917.

Concrete Piling.

Artificial Support for Buildings by Means of Concrete Piling. (Künstliche Befestigung des Baubodens mittels Schwebender Pilotage.) Ottokar Stern. Calculations and dimensions for concrete piling. Ills. 2300 w. Beton und Eisen—Jan., 1907. No. 83600 F.

Earth Slip.

The Earth Slip in the Face of the Embankment of the North Dike of the Wachusett Reservoir. Caleb Mills Saville. An account of the slip that occurred on April 11, explaining the conditions. Ills. 800 w. Eng News—April 25, 1907. No. 83911.

The Earth Slide at the North Dyke of the Wachusett Reservoir. A statement of the facts in regard to this slide, with illustrations. 1200 w. Eng Rec—April 27, 1907. No. 83943.

Excavator.

Neukirch Patent Excavating Apparatus (Ueber das Schrämverfahren Patent Neukirch). —— Seyboth. Ills. 5300 w. Glückauf—Feb. 23, 1907. No. 83663 D.

Foundations.

Concrete Pile Foundations for a Tower 700 Feet High. Describes foundation work at Coney Island, N. Y., for a steel structure intended for amusement purposes. Ills. 1600 w. Eng Rec—April 27, 1907. No. 83950.

Framework.

The Steel Framework of a Shop for Light Metal Work. Plan and description of a shop carefully designed to secure minimum weight and avoid interior obstructions, provide for extensive traveling crane service, roof lighting and drainage. 1800 w. Eng Rec—April 27, 1907. No. 83949.

Race Course.

A New Race Course for Parisians. Jean Schopper. An illustrated description of the new Tremblay race-course buildings which embody all the latest improvements. 1200 w. Archt Rec—May, 1907. No. 83929 C.

Reinforced Concrete.

A New Concrete Wood-Worsted Mill. E. S. Larned and Frank E. Warren. Illustrated description of the construction of an important manufacturing plant involving interesting work in reinforced concrete. The work was carried out with speed in freezing weather. 7500 w. Cement Age—April, 1907. No. 83787.

Reinforced Concrete in Power Station Construction. H. L. Knowlton. An illustrated article discussing successful applications of this material, and details of construction. 5500 w. Cassier's Mag—April, 1907. No. 83332 B.

Concrete Reinforcement for Irrigation Structures. F. W. Hanna. Explains some of the differences in the reinforcement for such structures from architectural practice. 1500 w. Eng News—April 4, 1907. No. 83448.

Reinforced Concrete Retaining Wall Design. Evan P. Bone. Explains the theory of design used for the walls, giving table and charts. 5500 w. Eng News—April 25, 1907. No. 83906.

Instructions for Reinforced Concrete Field Work. Extracts from a handbook of instructions prepared by the Engineering Department of the Trussed Concrete Steel Co. of Detroit. 2500 w. Eng Rec—April 6, 1907. No. 83482.

A Code of Instructions for Inspecting and Supervising Reinforced Concrete Construction Work. Extracts from the code of the Trussed Concrete Steel Co., of Detroit, Mich., giving instructions for this work. 6000 w. Engng-Con—April 24, 1907. No. 83922.

Roads.

Road Construction and Maintenance in Johannesburg. G. S. Burt Andrews. Explains the local conditions, the material available, and the work that has been done. General discussion. 9800 w. Jour S African Assn of Engrs—Feb., 1907. No. 83545 F.

Methods of Constructing and Repairing Oiled Roads in California. From the report of N. Ellery, State Highway Commissioner. Gives the plan followed on a good oiled earth highway. 2000 w. Engng-Con—April 24, 1907. No. 83921.

San Francisco.

Some Engineering Lessons of the San Francisco Disaster. J. L. Van Ornum. Especially discussing the fire lessons from this disaster as affecting different engineering materials. 2000 w. Jour Assn of Engng Socs—March, 1907. No. 83767 C.

Reinforced Concrete Construction. Lewis A. Hicks. Information in regard to reconstruction work, especially the use of reinforced concrete. 1400 w. Min & Sci Pr—April 20, 1907. No. 83963.

A Year of Reconstruction. Charles Derleth, Jr. Gives a brief review of the extent of structural damage within the earthquake and fire belt, with an outline of the rehabilitation accomplished during the past year. Ills. 5500 w. Min & Sci Pr—April 20, 1907. No. 83962.

The San Francisco of To-day. T. A. Rickard. Illustrations showing the progress of reconstruction, and descriptions of some of the work. 2500 w. Min & Sci Pr—April 20, 1907. No. 83961.

Steam Shovels.

Steam Shovels and Steam Shovel Work in Railway Construction. Discusses the recommendations of the Committee on Roadway of the American Railway Engineering and Maintenance of Way Assn., based on replies to a circular letter of inquiry. 2000 w. Eng News—April 11, 1907. No. 83563.

Structural Steel.

"Common Practice" and Common Defects in Structural Steel Work. Edward Godfrey. Points out some of the absurdities in designs of steel structures, giving examples of actually-observed instances of violations of common principles of mechanics. Ills. 4500 w. Eng News—April 11, 1907. No. 83565.

Theater.

Lincoln Square Theater. F. W. Mayes. Report on the design, construction and arrangement for public safety and fire protection. Ills. 2000 w. Ins Engng—March, 1907. No. 83588 C.

Tunnels.

Pennsylvania Railroad Tunnel Extension Into New York City. A. J. County. Abstract of an address before the Wharton Sch. Assn., Univ. of Penn. Outlines present conditions of transportation around Manhattan, and describes the project for improving the works now under construction by the Pennsylvania R. R. Map. 4200 w. R R Gaz—April 12, 1907. No. 83574.

Progress in Lowering the Tunnels Under the Chicago River. An illustrated report of progress in the lowering of the roofs of two street railway tunnels, and description of methods. 4000 w. Eng Rec—April 13, 1907. No. 83705.

The Tunnels Under the Seine for the Metropolitan Railway at Paris. R. Bonnin. Notes on very interesting work not described in a previous article in the issue of Feb. 15, 1906. Ills. 1200 w. Eng News—April 11, 1907. No. 83567.

The Kicking Horse River Tunnel of the Canadian Pacific Ry. Brief illustrated description of this new tunnel near Palliser, B. C. 1000 w. Eng News—April 18, 1907. No. 83895.

The Great Tunnel. An illustrated article dealing with the construction and use of the Simplon tunnel. 1600 w. Ry & Loc Engng—April, 1907. No. 83528 C.

Warehouses.

The Evolution of the Modern Warehouse. A. O. Elzner. Brief descriptions of old and new structures, especially illustrating a reinforced concrete fireproof building. 2000 w. Archt Rec—May, 1907. No. 83931 C.

The Storage Warehouse of the Fireproof Storage Co., Cleveland, O. Describes the erection of a reinforced concrete building with self-supporting shale-brick walls, 6 stories high. Ills. 1500 w. Eng Rec—March 30, 1907. No. 83368.

MATERIALS OF CONSTRUCTION.

Bricks.

The Story of the Brick. Prof. Edgar J. Banks. Reviews the history of early brick making, and shows how valuable they are in determining the age of ruins. 1200 w. Sci Am—April 6, 1907. No. 83456.

Cements.

Observations on the Testing and Use of Portland and Natural Cements. E. S. Larned. A discussion of tests and of facts from the experience of the writer in the use of this material, with general discussion. 7500 w. Jour N Eng W-Wks Assn —March, 1907. No. 83336 F.

Concrete.

Prevention of Freezing in Concrete by Calcium Chloride. Richard K. Meade. Gives results of a series of experiments made to investigate the effect which calcium chloride exercises in preventing the freezing of mortar. 2200 w. Eng Rec—April 20, 1907. No. 83837.

Concrete Blocks.

The Concrete Block and Its Advance to the Position of a First-Class Building Material. Clarence M. Barber. A discussion of concrete blocks as a building material, their construction, and the advantages claimed. 2200 w. Jour Assn of Engng Socs—March, 1907. No. 83768 C.

Concrete Mixing.

Some Representative Concrete Mixing Plants with Records of Operating Costs. F. W. Daggett. A description of plants, giving a summary of costs both of the installation and operation. Ills. 2000 w. Engng-Con—April 10, 1907. No. 83794.

Hard Woods.

The Hard-Woods of Western Australia. Information from two recent papers on the timbers of Australia, and recent tests made by G. A. Julius. Ills. 2500 w. Engr, Lond—March 22, 1907. No. 83426 A.

Marbles.

The Two Carraras. W. G. FitzGerald. An illustrated article describing the great marble quarries of Italy and of Vermont, the methods of quarrying, loading, etc. 2200 w. Archt Rec—May, 1907. No. 83930 C.

Piling.

Experience with Steel Sheet Piling in Hard Soils. William G. Fargo. Read at meeting of the Mich. Engng. Soc. Illustrates forms of sheet piling, and describes methods of driving and related matters, giving the cost. 2500 w. Eng News—April 4, 1907. No. 83450.

Reinforced Concrete.

A Theory of the Bending of Straight Reinforced-Concrete Girders (Essai d'une Théorie de la Flexion des Poutres Droites en Béton Armé). M. F. Chaudy. A mathematical discussion giving examples of application to different types of structures. Ill. 8000 w. Mem Soc Ing Civ de France —Feb., 1907. No. 83677 G.

Roofing Tin.

Manufacture of Roofing Tin. Description and illustrations of the process, from the casting of the iron ingots to the rolling of the plates and their immersion in pots containing molten tin and lead. 2000 w. Ins Engng—March, 1907. No. 83-589 C.

Sewer Pipe.

Cement Sewer Pipe. Two short papers, by Rudolph Hering, and by Robert W. Lesley, comparing the merits of cement and vitrified clay. 2700 w. Cement Age —April, 1907. No. 83788.

Wood Poles.

Note on the Cost of Preserving Wooden Poles (Beitrag zur Frage der Konservierung hölzerner Leitungsmaste). E. F. Petritsch. Account of various preservatives now used in Europe. 2900 w. Elektrotechnik und Maschinenbau—March 10, 1907. No. 83638 D.

MEASUREMENT.

Anemometer.

Electric Anemometer. R. Goldschmidt. Trans. from *Bul. de la Soc Belge d'Elec.* Illustrates and describes the apparatus. 1000 w. Bul Int Ry Cong—March, 1907. No. 83700 E.

Columns.

Stresses in Simple Columns Under Eccentric Load. O. H. Basquin. A discussion of some of the simple problems on the theory of stresses in columns. 3300 w. Eng News—April 18, 1907. No. 83893.

Leveling Rod.

A Tape Leveling Rod and Its Use. Arthur W. Tidd. Illustrated description of a sliding tape rod by means of which elevations are read off directly. 1200 w. Eng News—April 25, 1907. No. 83907.

Reinforced Concrete.

Diagrams for Proportioning Reinforced Concrete Beams. Gives diagram drawn up by A. H. Perkins, with explanatory notes. 900 w. Eng News—April 25, 1907. No. 83908.

The Use of Tables and Diagrams for Proportioning Reinforced Concrete Members. Editorial warning in regard to the misuse of these aids for conditions to which they are not applicable. 1300 w. Eng News—April 25, 1907. No. 83910.

Retaining Walls.

A Diagram for Overturning Moments on Retaining Walls for Earth or Water. Gives a graphical solution of the Rankine retaining wall formula, which was constructed by Charles H. Hoyt, who has found it a time-saver in retaining-wall work. 700 w. Eng News—April 25, 1907. No. 83909.

Roof Truss.

Calculation of a Two-Hinged Arched Roof Truss (Calcul d'une Ferme en Arc à deux Articulations). E. Aragon. Graphical solution of stresses due to dead and wind loads. Ill. Serial. 1st part. 3500 w. Génie Civil—March 23, 1907. No. 83694 D.

Water Percolation.

New Method of Determining the Direction and Rate of Percolation of Ground Water (Neue Verfahren zur Bestimmung von Richtung und Geschwindigkeit der Grunwasserströmungen). Reinhold Ulfert. Illus. 2300 w. Gesundheits Ingenieure—March 23, 1907. No. 83644 D.

Water Power.

Methods and Results of the Wisconsin Water Power Survey. L. S. Smith. An account of the methods used and cost of this work. 2000 w. Wis Engr—April, 1907. No. 83858 D.

MUNICIPAL.

City Improvements.

Recent Reports on City Plans. Charles Mulford Robinson. Outlines of proposed improvements in St. Paul, St. Louis, Boston and New York. Recommendations for parks, parkways, wider thoroughfares, bridge approaches, etc. Ills. 3000 w. Munic Jour & Engr—April 3, 1907. No. 83437 C.

Garbage.

An 18-Ton Garbage Crematory. Illustrated description of a crematory at Port Ontario, N. Y., designed to destroy 18 tons of the house wastes in 24 hours. 800 w. Eng Rec—April 13, 1907. No. 83707.

Hygiene.

Second International Congress on Hygiene at Geneva, 1906 (Der II Internationale Kongress für Wohnungshygiene in Genf 1906). A. G. Stradal. Abstract of papers read at the convention. Tables. Serial. 2 parts. 7200 w. Zeitschr d Oesterr Ing und Arch Vereins—Feb. 1 and Feb. 8, 1907. No. 83615 each D.

Pavements.

Macadam Streets, Surfaced with California Liquid Asphalt, as Constructed in the City of Redlands, Cal. C. C. Brown. Describes methods found satisfactory on streets with steep slopes. Ills. 1000 w. Eng News—April 4, 1907. No. 83445.

Roads.

Methods and Cost of Reducing Dust and Hardening Roads by Surface Applications. J. W. Howard. Discusses the treatment of earth, sand, gravel, and macadam roads by surface applications. 5500 w. Engng-Con—April 3, 1907. No. 83473.

The Asphaltic-Oiled and Tamper-Rolled Compressed Dirt Roads of Santa Monica, Cal. Gives specifications for the constructing of oiled dirt roads. Ill. 1300 w. Eng News—April 4, 1907. No. 83446.

Petrolithic Pavement: A New Method of Oiled Road Construction. Illustrated description of this new type of road and the machine with which it is constructed. 1200 w. Engng-Con—April 17, 1907. No. 83795.

Rochester, N. Y.

The Public Works of Rochester, N. Y. Illustrates and describes the new Cobb's Hill reservoir, and the efficient street-lighting system. 2000 w. Munic Engng—April, 1907. No. 83595 C.

Septic Tanks.

The Explosion of the Saratoga Septic Tank. Prof. W. P. Mason. An account of the accident with discussion of the cause. Also general discussion. Ill. 4000 w. Jour N Eng W-Wks Assn—March, 1907. No. 83337 F.

The Septic Tank of the Belleville, Ill., Sewerage System. Plan and sections with description of a tank with a capacity for treating the normal dry weather flow from a system serving a population of 30,000. 1600 w. Eng Rec—April 13, 1907. No. 83710.

Sewage.

The Bacterial Treatment of Sewage, with Special Reference to the Biolysis of Organic Nitrogen. W. D. Scott-Moncrieff. Briefly considers the successive stages in the breaking down of organic matter, especially discussing the third, or nitrifying changes. Diagrams, tables, and discussion. 7800 w. Jour Ry San Inst—April, 1907. No. 83585 B.

Nitrification of Sewage. George Reid. Summary of a paper read before the Ry. Soc. Discusses the construction of filter beds so as to afford the largest possible surface for bacterial growth under healthy conditions. 3000 w. Jour Roy San Inst—April, 1907. No. 83586 B.

The Common Sense of Sewage Pollution. George Ethelbert Walsh. Discusses the proper disposal of municipal sewage. The present article considers the land treatment. 1500 w. Dom Engng—April 6, 1907. Serial. 1st part. No. 83506.

The Sewage Disposal Plant of the Soldiers' Home, Johnson City, Tenn. Describes a plant comprising a septic tank, four contact beds, and four sand filters, designed to operate under a wide variation of flow. 2000 w. Eng Rec—April 27, 1907. No. 83946.

Sewage Disposal Tanks for the Isolated House. Illustrates and describes flush tanks suitable for handling sewage in the process of its disposal. 1800 w. Met Work—April 27, 1907. No. 83932.

Sewage Beds.

An Experience with Clogged Sewage Beds at Pawtucket, R. I. Notes from a bulletin issued by the State Board of Health of Rhode Island in regard to investigations at Pawtucket. 2000 w. Eng Rec—March 30, 1907. No. 83369.

Sewage Filters.

Eight Years' Work with Trickling Sewage Filters at the Lawrence Experiment Station. H. W. Clark. A review of the studies made of such filters at the station named and the results. 5000 w. Eng News—April 11, 1907. No. 83566.

Smoke.

Steps in the Development of a Smokeless City. W. F. M. Goss. Read before the Indiana Acad. of Science. Suggests measures for rendering a city smokeless. 2500 w. Munic Engng—April, 1907. No. 83596 C.

The Smoke Nuisance and Industry (Die Rauchplage und die Industrie). Etienne de Fodor. Various systems of prevention and consumption of smoke discussed. Serial. 2 parts. 9600 w. Elektrotechnik und Maschinenbau—March 3 and March 10, 1907. No. 83637 D.

Stone Crushing.

A Large Stone-Crushing Plant at Gary, Ill. Illustrated description of a new plant having a rated capacity of 300 cu. yds. an hour. 1800 w. Eng Rec—March 30, 1907. No. 83372.

WATER SUPPLY.

Cast-Iron Pipe.

Some Observations on Cast-Iron Pipe Specifications. William R. Conrad. Short paper and general discussion of the New England specifications, and the report of the Committee on Standard Specifications. 7500 w. Jour N Eng W-Wks Assn—March, 1907. No. 83339 F.

Croton Dam.

The New Croton Dam. An illustrated description of the design and construction of this large masonry dam for the additional water supply of New York City. 1700 w. Engr, Lond—April 12, 1907. Serial. 1st part. No. 83885 A.

Fire Protection.

Maintenance Methods and Detailed Costs of Car House Fire Protection in Cleveland. An illustrated account of the ways and means of taking care of the extensive sprinkler system installed. 2500 w. St Ry Jour—March 30, 1907. No. 83359.

Hamburger Test.

The Hamburger Test for Pollution (Der Hamburger Test auf Fäulnisfähigkeit). Dr. Korn and Dr. Kammann. Tables. 3900 w. Gesundheits Ingenieur —March 16, 1907. No. 83642 D.

Irrigation.

Millions for Moisture. C. J. Blanchard. An illustrated account of the work of the United States reclamation service. 6400 w. Nat Geog Mag—April, 1907. No. 83853 C.

The Government Irrigation Project at Roosevelt Dam, Salt River, Arizona. Prof. Oscar C. S. Carter. Remarks on the irrigation of this region before the Government took the matter in charge, with information of the projects since carried out or under construction, especially the Roosevelt dam. Ills. 7500 w. Jour Fr Inst—April, 1907. No. 83758 D.

Meters.

Meter Registration. Arthur N. French. An account of a water meter which registered when no water was passing through the pipes, explaining the cause and remedy. General discussion. 6800 w. Jour N Eng W-Wks Assn--March, 1907. No. 83338 F.

Montreal.

Montreal's Water Supply. An account of proposed improvements with the estimated cost. 1700 w. Can Engr—April 5, 1907. No. 83504.

Oregon.

The Water Supply of the Oregon Short Line at Pocatello, Idaho. Describes an extensive system supplying division shops and furnishing water for general railroad use. Illustrates details. 2000 w. Eng Rec —April 27, 1907. No. 83944.

Purification.

The Cincinnati Water Purification Plant. E. G. Monahan, and J. W. Ellms. Illustrated description of the plant and method of operation, reviewing the past history of the water supply, and giving costs. 7000 w. Eng Rec—April 6, 1907. No. 83479.

See Railway Engineering, Motive Power and Equipment.

Supply.

The Struggle for Water in the Great Cities of the United States. Marsden Manson. Presents certain features of the great problems of municipal water supply. Considers ownership, and those requiring change of source or expensive treatment. New York and San Francisco are taken as examples. 8000 w. Jour Assn of Engng Socs—March, 1907. No. 83765 C.

WATERWAYS AND HARBORS.

Barge Canal.

The Section of the Barge Canal Connecting the Hudson and Mohawk Rivers. H. P. Willis. Brief illustrated account of the interesting work on this section. 600 w. Eng Rec—March 30, 1907. No. 83373.

The New York Barge Canal Improvements. William G. Landreth. Gives map and profile for the barge canal now being built, describing the location of locks and dams and other features of the work. 2200 w. Eng Rec—April 13, 1907. No. 83708.

Canada.

The Canadian Waterway to the Atlantic. H. K. Wicksteed. An address before the Canadian Club, Montreal. An explanation of the project with description of the route. 4500 w. Can Engr—April 5, 1907. No. 83503.

Docks.

Difficult Underpinning and Dock Work in Chicago. Illustrates and describes some complicated dock and underpinning work in connection with the increase in the width of the Chicago River. 1800 w. Eng Rec—April 20, 1907. No. 83833.

Dredges.

Dredges (Les Dragues). A. Baril. The first instalment of this article deals with bucket dredges, outlines their history, describes various types and operations and gives details of capacity, etc., under different conditions of work. Ill. Serial. 1st part. 7000 w. Rev de Méch—March 31, 1907. No. 83681 E + F.

Electric Haulage.

Electric Haulage of Boats (Halage Electrique des Bateaux). Léon Gerard. Results of experiments on electric haulage on canals carried out by the General Electric Company in 1905, description of tractor, etc. Ill. 3300 w. L'Alliance Industrielle—April, 1907. No. 83685 D.

Harbors.

Notes on Harbor Engineering. J. R. Baterden. A discussion of the effects of wave action, and other matters relating to structures in the sea. 3000 w. Engr, Lond—April 5, 1907. No. 83749 A.

The Harbor Improvements at Salina Cruz, Mexico. Illustrated notes on the terminal facilities of the Pacific terminus of the Tehuantepec National Railroad. 1300 w. Eng Rec—March 30, 1907. No. 83365.

The Entrance to the Mersey. An account of improvements to be made at the Port of Liverpool for the safety and convenience of ships. 2200 w. Engng—March 15, 1907. Serial. 1st part. No. 83465 A.

Inland Waterway.

The North Carolina-Virginia Inland Waterway. H. L. Wilson. Illustrates and describes this project, the two routes under consideration, and states the advantages of having a complete inland passage from Chesapeake Bay to and through Beaufort Inlet. Map. 1300 w. Sci Am—April 13, 1907. No. 83576.

Lift Locks.

The Kirkfield Hydraulic Lift Lock. Illustrated description of this recently completed lock on the Trent Canal, Ontario, and its operation. 2000 w. Eng Rec—March 30, 1907. No. 83370.

Piston Lifts for Ships (Ueber Kolbenhebewerke für Schiffe). Artur Budau. Description of caisson lifts used on canals. Illus. Serial. 2 parts. 5600 w. Zeitschr d Oesterr Ing u Arch Vereins—Feb. 1 and Feb. 8, 1907. No. 83614 each D.

Missouri.

Improvement Work on the Missouri River (Travaux d'Amélioration du Missouri). F. Marchais. A summary of the methods which have been tried to improve navigation on the Missouri and the work now in hand. Ill. 4000 w. Génie Civil—April 6, 1907. No. 83683 D.

Panama.

The Present Status of the Panama Canal. An account of what has been accomplished, and the work in progress, the most pressing need at the Colon terminus of a system of breakwaters to provide a safe harbor. 3800 w. Engng—March 15, 1907. No. 83467 A.

Paraná.

Ship Canal from Buenos Ayres to the Paraná de Las Palmas (Canal Marítimo de Buenos Aires al Paraná de Las Palmas). Julio B. Figuerva. The first part of the serial outlines the nature of the project and discusses the problems to be solved. Ill. Serial. 1st part. 4500 w. La Ingenieria—Jan. 30, 1907. No. 83995 D.

Rhine.

Rectification of the Rhine and the Cut at Diepoldsau (Die Rheinkorrektion und der Diepoldsauer Durchstich). Detailed description of improvement works on the lower stretches of the Rhine. Illus. Serial. 3 parts. 5800 w. Schweizerische Bauzeitung—Jan. 5, Jan. 12, and Jan. 19, 1907. No. 83619 each B.

Rosario.

Fascine Protection Works at the Port of Rosario (Puerto del Rosario: Obras de Faginado). Domingo Carrique. Illustrated description of the method used for protecting the shore by means of fascines. 2000 w. La Ingenieria—Feb. 15, 1907. No. 83672 D.

Teltow.

The Teltow Canal (Verein für Eisenbahnkunde zu Berlin—Ueber den Teltowkanal). Havestadt. Paper presented to the Berlin Railway Club; a complete account of the canal. Illus. 5600 w. Glasers Annalen—March 15, 1907. No. 83624 D.

The Electrical Equipment of the Teltow Canal. Brief illustrated description. 1500 w. Elec Rev, Lond—April 19, 1907. No. 83991 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Arcophone.

How to Construct a Speaking Arc. A. Frederick Collins. Description and diagrams with explanation of the theory and of some of the applications. 2000 w. Sci Am Sup—April 27, 1907. No. 83915.

Radio-Telegraphy.

Arrangement of Wireless Telegraph Apparatus. D. McNicol. Gives a diagram and description of an arrangement explaining its merits. 700 w. Elec Wld—April 6, 1907. No. 83496.

Telegraphy.

The Baudot Telegraph System in India. C. T. Williams. Brief description of this system and its working in India. Ills. 3000 w. Elect'n, Lond—March 22, 1907. No. 83418 A.

Experimental Study of Telegraph Lines and Apparatus (Etude Expérimentale des Lignes et des Appareils Télégraphique). M. Devaux-Charbonnel. Researches on the resistance and insulation, capacity, self-inductance, etc., of telegraph lines. Mathematical discussion. Ill. 9000 w. Bull d l Soc Inter d'Elec'ns—Mar., 1907. No. 83696 F.

Telephony.

Aspects of Recent Telephone Development. Howard S. Knowlton. Remarks on the remarkable increase in telephone traffic and an explanation of why the telephone message should be considered the unit. 2500 w. Elec Wld—Mar. 30, 1907. No. 83352.

Notes on the Development of Telephone Service. Fred De Land. Considers the forms of transmitters and the development of the wall telephone, and related subjects. Ills. 3000 w. Pop Sci M—May, 1907. No. 83920 C.

The Telephone Repeater. Louis Cohen. Discusses the requirements of a telephonic repeater, explaining how it differs from a telegraphic repeater. 800 w. Elec Wld—April 6, 1907. No. 83499.

Induction on Telephone Lines (Inductie verschiznselen op telefoonlijnen). A. A. Oosting. Outline of several methods of avoiding inductive disturbances on telephone circuits. Illus. 5900 w. De Ingenieur—Mar. 2, 1907. No. 83656 D.

DYNAMOS AND MOTORS.

Brushes.

Brush Holders and Brushes for 500-Volt Motors. Eugene C. Parham. Considers troubles incident to abuse, neglect, poor design, or bad condition of the commutator. 1500 w. Elec Wld—April 6, 1907. Serial. 1st part. No. 83501.

Brushholders.

Some Brushholder Experiences. Henry Schlegel. Discusses what may be expected where brushholders are neglected or are maintained by incompetent labor unaided by the necessary jigs and gages. 3500 w. St Ry Jour—April 13, 1907. No. 83704.

Circulating Currents.

Circulating Currents in Three-Phase Generators. A. G. Grier. Explains the limitations of the wave form in the three-phase system, giving an analysis of the wave forms of a three-phase star-connected generator in which circulating currents were known to exist when connected in delta. Diagrams and tables. 2000 w. Elec Jour—April, 1907. No. 83582.

D. C. Dynamos.

Unstable Conditions in the Operation of Direct Current Machines (Unstabile Betriebszustände bei Gleichstrom Maschinen). Karl Willy Wagner. Mathematical discussion. 2000 w. Elektrotechnische Zeitschrift—March 28, 1907. No. 83652 B.

Induction Motors.

A New Type of Induction Motor. Louis J. Hunt. Read before the Manchester Soc. of the Inst. of Elec. Engrs. Illustrates and describes a motor possessing all the characteristics of the ordinary type of slip-ring induction motor, but differing from it in the arrangement of the windings. 3500 w. Mech Engr—April 13, 1907. No. 83869 A.

Calculation of the Leakage-Reactance of Induction Motors. J. E. Hanssen. Presents, in a condensed form, the formulae contained in Prof. Adams' papers, which in practice have proved to be accurate and convenient. 1000 w. Elec Wld—March 30, 1907. No. 83351.

Zig-zag Leakage of Induction Motors. R. E. Hellmund. A study of the values of zig-zag leakage. Diagrams. 3000 w. Pro Am Inst of Elec Engrs—March, 1907. No. 83764 D.

Winding Diagrams.

Continuous-Current Armature Winding Diagrams. H. M. Hobart. An explanation of the practice of diagrammatically representing windings of armatures. Ills. 2500 w. Elec Rev, N Y—March 30, 1907. Serial. 1st part. No. 83348.

DISTRIBUTION.

Switch Indicator.

A New End-Cell Switch Indicator. A. A. Radtke. Illustrated description of a new form of end-cell switch indicator designed to replace the telephone drop type. 800 w. Elec Wld—April 13, 1907. No. 83717.

Systems.

Electric Distribution Systems. Prof. A. H. Ford. Extract from a paper read before the Iowa Elec. Assn. Discusses the selection and design of a system from the standpoint of cost and operating characteristics. 2000 w. Elec Wld—April 27, 1907. No. 83976.

Three-Phase.

Three-Phase Four-Wire Distribution. H. L. Wallau. Shows the high transmission efficiency and economy of this system. Diagrams. 2000 w. Elec Age—April, 1907. No. 83956 C.

Wiring.

Bell and Telephone Work in Fireproof Buildings. T. W. Poppe. Suggestions for wiring. Ills. 900 w. Elec Wld—April 6, 1907. No. 83498.

ELECTRO-CHEMISTRY.

Bleaching.

Electric Bleaching (Zum Kapitel: Elektrische Bleiche). V. Engelhardt. Abstract discussion of the subject. 2400 w. Electrochem Zeitschr—March, 1907. No. 83670 G.

The Problems of Bleaching with Paper-Pulp Electrolytic Hypochlorite Solutions. W. Pollard Digby. Notes on investigations made by the writer which lead him to believe very strongly in the possibilities of electrolytic hypochlorite processes for paper and textile bleaching. 4500 w. Elec-Chem & Met Ind—May, 1907. No. 83979 C.

Calcium.

Critical Review of the Electrolytic Production of Calcium (Kritische Betrachtungen Ueber Die Elektrolytische Gewinnung Des Calcums). Carl Bürgel. Detailed description of processes. Continuation of serial. Illus. 2100 w. Elektrochem Zeitschr—March, 1907. No. 83671 G.

Electric Furnaces.

New and Unique Electric Furnaces Without Electrodes. Frank C. Perkins. An illustrated description of the Hiorth induction electric furnace. 900 w. Min Rept—March 28, 1907. No. 83377.

Old and New Patterns of Electric Furnaces (Ueber elektrische Ofen älterer und neuer Systeme). Gustav A. Pummer. Descriptive article, treating of various types that have been tried. Illus. Serial. 2 parts. 3200 w. Oesterr Zeitschr f Berg und Hüttenwesen—March 2 and 9, 1907. No. 83636 each D.

Electrolysis.

Soil Electrolysis with Formation of a Liquid Sodium Potassium Alloy. Henry Bassett, Jr. Describes a case showing the magnitude of the chemical processes which may be caused by such earth currents. 3000 w. Elect'n, Lond—April 12, 1907. No. 83876 A.

Electroplating.

The Electroplating of Plaster of Paris Objects. Illustrates and describes the process of coating works of art with metal. 4800 w. Brass Wld—April, 1907. No. 83928.

Films.

The Capacity and Resistance of Aluminium Anode Films. C. McCheyne Gordon. Abstracted from the *Phys. Rev.* A study of these films, describing investigations. 2500 w. Elect'n, Lond—March 22, 1907. No. 83419 A.

Glocken Process.

The Aussig Glocken Process for Alkali Chloride Electrolysis. Dr. Otto Steiner. An explanation of the process, stating its advantages and disadvantages. 2000 w. Elec-Chem Met Ind—May, 1907. No. 83977 C.

ELECTRO-PHYSICS.

Arresters.

Multi-Gap Lightning Arresters with Ground Shields. R. B. Ingram. Calls attention to phenomena in the operation of lightning arresters of the multi-gap type regarding the effect of variation in the relative position of the multi-gaps and the ground and the distance between them, and explains the use of the ground shield as a remedy. 1700 w. Elec Jour—April, 1907. No. 83583.

Electric Waves.

Electric Wave Propagation. J. E. Taylor. Read before the Inst. of P. O. Elec. Engrs. The paper aims to give mental pictures of the actions and processes underlying electric wave propagation. Diagrams. 3500 w. Elec Rev, Lond—April 19, 1907. Serial. 1st part. No. 83992 A.

Induction Coils.

The Making of Small Induction Coils with Bare Wire. A. Frederick Collins. Describes a method of winding with bare wire on the primary helix instead of using insulated wire. Ills. 1500 w. Sci Am Sup—April 13, 1907. No. 83580.

Insulation.

The Insulation of Electrical Appliances. O. J. Williams. Abstract of a paper read before the Newcastle Loc. Sec. of Inst. of Elec. Engrs. Reviews the elementary phenomena of dielectrics, and explains to some extent the scientific basis on which effective insulation depends. 1500 w. Elecn'n, Lond—April 12, 1907. No. 83875 A.

Magnetic Detector.

The Construction of a Magnetic Detector. Edward G. Gage. Gives directions for making a home-made detector, with brief notes on early researches. Ills. 2000 w. Sci Am—April 6, 1907. No. 83457.

Resistivity.

The Resistivity-Temperature Coefficient of Metals. Harold Pender. The object of the note is to put into convenient form for easy calculation the ordinary formula for the change in the resistivity of copper with the change in temperature. 300 w. Elec Wld—April 13, 1907. No. 83719.

GENERATING STATIONS.

Beznau.

Electric Power Station at Beznau on the Aar (Elektrizitätswerk Beznau an der Aare Anlage für die Erzeugung elektrischer Energie). Comprehensive description of a large combined hydraulic and steam plant in Switzerland. Illus. Serial. 7 parts. 10000 w. Schweizerische Bauzeitung—Feb. 9, 16 and 23, March 2, 16, 23 and 30, 1907. No. 83632 each B.

Card Records.

Notes on a Central Station Card Record System. George W. Martin. Describes the manner in which the United Electric Light and Power Company, of New York, keeps track of its customers and the apparatus used by them. 2000 w. Elec Wld—April 6, 1907. No. 83494.

Frequency.

Frequency Changers. J. P. Jollyman. Considers some of the operating features of 60 to 25, or 25 to 60 cycle synchronous frequency changers. 1200 w. Elec Wld—April 6, 1907. No. 83500.

Hungary.

Electric Power Plants in Austro-Hungary (Die Starkstrom-Industrie in Oesterreich-Ungarn). Emil Honigmann. Enumeration of all the important Hungarian plants, with tables giving particulars of kind of prime mover employed, kilowatts capacity, kind of service furnished, etc. Serial. 2 parts. 5200 w. Elektrotechnische Zeitschrift—March 7 and 14, 1907. No. 83648 each B.

Hydro-Electric.

Overcoming Loss of Head from Flooding. Enrico Bignami. An account of experiments at Chevres, near Geneva, for utilizing the unused kinetic energy wasted because of the flood to return to the station part of the energy lost on account of the loss in head. 1500 w. Engr, U S A —April 1, 1907. No. 83380 C.

The Hydro-Electric and Water Power Plant of a Large Paper Mill. Illustrates and describes a recently completed large pulp and paper mill in Minnesota on the Mississippi River, especially its power equipment. 3500 w. Eng Rec—April 6, 1907. No. 83481.

The Central Station of the Albula (La Centrale Elettrica dell' Albula). Details of this new station for the supply of electrical energy to the city of Zurich. 3000 w. L'Elettricita—March 1, 1907. No. 83678 D.

The Sill Power Plant near Innsbruck (Die Sillwerke bei Innsbruck). Comprehensive description of a large hydro-electric plant in Tyrol, Austria. Illus. Serial. 2 parts. Elektrotechnik und Maschinenbau—March 24 and 31, 1907. No. 83640 each D.

London.

The Electrical Power Supply of London. C. S. Vesey-Brown. Explains the difficulties encountered, giving a brief review of the establishment of electrical supply as far as it concerns London, proper, and discussing proposed schemes. 6000 w. Cassier's-Mag—April, 1907. No. 83333 B.

Municipal Plant.

A Successful Municipal Lighting and Power Plant. Describes the plant at South Norwalk, Conn., giving an account of its history, development and growth. Ills. 2500 w. Elec Wld—April 6, 1907. No. 83493.

Power Plants.

The Design of a 1500 to 3000-kilowatt Steam-Electric Central Light and Power Plant. Frank Koester. Brief discussion of the questions involved in the design of a small plant. Ills. 4000 w. Elec Rev, N Y—April 20, 1907. Serial. 1st part. No. 83839.

The Central Power Station at the Plant of Walter Baker & Co., Ltd. Illustrated description of a plant for supplying power for a group of buildings, showing the economy of electric distribution. 3000 w. Eng Rec—April 20, 1907. No. 83836.

Potomac Electric Power Company's New Plant. C. H. Claudy. Illustrated description of a large steam-turbine station of interesting design, concrete-block construction, erected at Washington, D. C. 2500 w. Power—May, 1907. No. 83860 C.

A Small Central Station in Nebraska. Jas. A. Ward. Illustrated detailed description of an electric light plant for a place of about 1000 inhabitants. 2500 w. Elec Wld—March 30, 1907. No. 83350.

The Central Station for Heating, Light, and Power at Glen Eyrie. Konrad Meier. Plan and description of the plant on a country estate near Colorado Springs, Colo. 5500 w. Eng Rec—April 27, 1907. No. 83941.

Regulators.

Induction Potential Regulators. W. T. Fernandez. Describes a type of transformer used in conjunction with polyphase rotary converter systems for the purpose of providing a method of variable control of the secondary voltage on the alternating-current side of the machines. 1600 w. Elec Wld—April 6, 1907. No. 83497.

Switch-Gear.

Extra-High-Tension Switch-Gear. Introductory remarks on the rapid evolution of switch-gear, with an illustrated description of the gear recently constructed for the St. Andrew's Cross Station of the Glasgow Corporation. Plate. 3000 w. Engng—March 29, 1907. Serial. 1st part. No. 83553 A.

Turbo-Alternators.

Two-Pole Turbo-Alternator with Stationary Field and Magnetically-Shunted Exciter. A. Hegland. Discusses means of reducing the capital cost of such machines, with special reference to two-pole machines. 3500 w. Elect'n, Lond—April 12, 1907. No. 83872 A.

Water Power.

The Cataract of Iguazu. Henry Harley. Illustrates several cataracts of South America capable of developing vast power, especially describing the cataract named on the Upper Parana. 2000 w. Cassier's Mag—April, 1907. No. 83330 B.

LIGHTING.

Arc Lamps.

Recent Progress in Arc Lamps: Flaming Arcs (Les Progrés Récents des Lampes à Arcs: les Arcs à Flamme). M. Blondel. A thorough discussion of this class of arc lamp, descriptions of different types, their construction, operation and principles. Serial. 1st part. Ill. 10500 w. Bull d l Soc Inter d'Elec'ns—March, 1907. No. 83697 F.

Costs.

Comparative Costs of Gas and Electric Lighting. E. G. Hennard. Read before the Students' Sec. of the Inst. of Elec. Engrs. Gives a brief study of the prices of gas and electricity in London, and a general consideration of lighting costs, with explanation of methods used. 2300 w. Elec Engr, Lond—April 19, 1907. Serial. 1st part. No. 83989 A.

Frosted Lamps.

An Analysis of the Causes of Candle-

Power Diminution in Frosted Lamps. Preston S. Millar. Discusses the nature of the causes of rapid depreciation of lighting with frosted lamps. Also editorial. 3000 w. Elec Wld—April 20, 1907. No. 83852.

An Explanation of the Short Life of Frosted Lamps. Edward P. Hyde. An explanation of the rapid decrease in candle-power of frosted lamps. 1500 w. Elec Rev, N Y—April 6, 1907. No. 83485.

Illumination.

The Relative Efficiency of Light Sources. E. Percival Lewis. Explains the nature of the problem of illumination and suggests the direction in which progress may be expected, describing some recent improvements in methods of lighting. 2500 w. Cal Jour of Tech—April, 1907. No. 83954.

Comparison of Methods of Office Illumination. Edward A. Norman. Abstracted from a paper before the Ill. Engng. Soc. Shows results obtained by three different methods of office illumination, comparing the relative efficiencies, and presents results secured by arc lamps of the concentric diffuser type in a drafting room. Ills. 2000 w. Elec Rev, N Y —April 27, 1907. No. 83951.

Lamps.

The Effect of High Efficiency Lamps on the Electric Lighting Industry. W. Tatlow. Read before the Dublin Loc. Sec. of the Inst. of Elec. Engrs. Discusses the effect of the new lamps on the design of a private installation, showing how low voltage lamps may be used without the necessity of a transformer to transform the whole current required. 2000 w. Elect'n, Lond—April 12, 1907. No. 83874 A.

The Small Station and the New Lamps. Harry V. Forest. Discusses the changes anticipated in the electric lighting business from the introduction of high efficiency lamps, giving suggestions. 1500 w. Elec Wld—April 6, 1907. No. 83495.

Train Lighting.

The Verity-Dalziel System of Train Lighting. Illustrated description. 1200 w. Elec Rev, Lond—March 29, 1907. No. 83547 A.

Tungsten.

The Tungsten Lamp (La Lampe au Tungsténe). A. Bainville. Details of their manufacture and utility showing curves of lighting power. Ill. 1200 w. L'Elec'n —March 23, 1907. No. 83687 D.

Vacuum-Tube.

The Moore Vacuum-Tube Light and the Luminosity of Gases. C. J. Thatcher. A brief description of this lamp and a consideration of its salient features, and its possible bearing on gaseous luminosity. 3200 w. Elec-Chem & Met Ind—May, 1907. No. 83980 C.

MEASUREMENT.

Candle Power.

Measurement of the Instantaneous Candle Power of Alternating Current Lamps. (Messung der Momentanwerte der Lichtstärken von Wechselstromlampen). Johann Sahulka. Illus. 2600 w. Elektrotechnik und Maschinenbau—March 17, 1907. No. 83639 D.

Core Losses.

Eddy Current Losses in Armature Teeth. F. E. Meurer. Develops a method by which the core losses in dynamo-electric machinery may be determined with the aid of only a small amount of empirical approximation. 3000 w. Elec Wld—April 20, 1907. No. 83850.

Gauge.

Frahm's Speed and Frequency Gauge. Frederick Lux. Gives an explanation of resonance and an illustrated description of the Frahm resonance speed gauge and its use. 4500 w. Bul Int Ry Cong—March, 1907. No. 83599 E.

Insulation.

Measurement of Wire and Cable Insulation. Tracy D. Waring. An article suggested by a recent paper by F. Wachter giving a summary of the sources of error met with in the measurement of cable insulation resistances. 2500 w. Elec Wld—April 20, 1907. No. 83851.

Iron Testing.

The Testing of Iron Electrically and Magnetically for Commercial Purposes. P. R. Fortin. Abstract of a paper read before the Northampton Inst. Engng. Soc. Describes the equipment and routine of a works laboratory, especially the tests for permeability and for energy losses. 1600 w. Elec Engr, Lond—March 22, 1907. No. 83417 A.

Losses.

The Experimental Determination of the Losses in Motors. Charles F. Smith. Read before the Manchester Sec. of the Inst. of Elec. Engrs. The present number deals with direct-current motors, and the methods of separating the losses, giving tests. 3000 w. Mech Engr—April 20, 1907. Serial. 1st part. No. 83988 A.

Ondameter.

The Ondameter or Electric Wave Meter. Illustrated description of the construction and operation. 1000 w. Sci Am Sup—April 6, 1907. No. 83463.

Testing.

Rules Concerning the Acceptance and Testing of Electric Machines, Transformers and Apparatus (Régles Concernant la Réception et les Essais des Machines, Transformateurs et Appareils Electriques). Regulations of the Milan Association of Users of Electrical Energy. 2800 w. L'Elec'n—March 23, 1907. No. 83688 D.

Watt.

What is a Watt? George Sherwood Hodgins. An explanation of this electrical term. 1400 w. Ry & Loc Engng—April, 1907. No. 83532 C.

Wattmeter.

Siemens & Halske Improved Wattmeter (Das Drehstrom Wattmeter der Siemens & Halske, A. G.; und eine Neukonstruktion ihres Präzisions-Wattmeters). Hilmar Sack. Detailed description of the instruments and calculation of their limits of accuracy. Illus. 2000 w. Elektrotechnische Zeitschrift—March 21, 1907. No. 83650 B.

TRANSMISSION.

Alternating Currents.

Drop in Alternating-Current Circuits. Charles F. Scott and Clarence P. Fowler. Describes a modification of the usual method of finding the drop. Tables and diagrams. 1200 w. Elec Jour—April, 1907. No. 83584.

Cables.

Some Notes on Underground Mains. W. M. Rogerson. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Briefly describes the various methods of laying cables underground and the maintenance of mains, giving the author's experiences. 4500 w. Elect'n, Lond—April 5, 1907. No. 83740 A.

The Depreciation of Underground Cables. F. Fernie. Discusses the different single cable systems and their relative advantages as regards depreciation. 3300 w. Elec Rev, Lond—April 5, 1907. No. 83739 A.

High Tension.

Pressure Rise on High-Tension Transmission Lines. E. Hudson. Read before the Dick-Kerr Engng Soc. Discusses the direct causes of pressure rise. 2000 w. Elec Engr, Lond—March 22, 1907. No. 83416 A.

Insulation.

Rubber Insulation. William A. Del Mar. Briefly discusses the adulteration, vulcanization, and, quality of rubber, and other matters determining its suitability for insulating uses. 3000 w. Elec Age—April, 1907. No. 83955 C.

Leakage.

The Localization of Earth Leakages on a Three-Wire Network. W. A. Toppin. Discusses systems for the actual location of the leakages, giving diagrams. 2000 w. Elec Engr, Lond—April 12, 1907. No. 83870 A.

Lightning.

Lightning Phenomena in Electric Circuits. Charles P. Steinmetz. Explains the most general meaning of lightning, discussing in detail the phenomena of abnormal voltage and frequency in electric circuits, showing how vast is the problem. Diagrams. 5000 w. Pro Am Inst of Elec Engrs—March, 1907. No. 83763 D.

INDUSTRIAL ECONOMY

Accounting.

A System of Coal-Mine Accounting. F. A. Hill. Explains a system evolved by the writer which has proved satisfactory in use. 1300 w. Eng & Min Jour—March 30, 1907. No. 83357.

Chemistry.

The Methods and the Importance of the System of Organic Chemistry (Die Methoden und die Bedeutung der organisch-chemischen Technik). Otto N. Witt. Discussion of the commercial importance of organic chemistry. 5100 w. Zeitschr d Oesterr Ing u Arch Vereines—March 15, 1907. No. 83654 D.

The Interrelation of Chemistry and Engineering in Technology (Das Zusammenwirken von Chemie und Ingenieurwesen in der Technik). George Lunge. Serial. 3 parts. 8200 w. Zeitschr d Oesterr Ing u Arch Vereines—Feb. 15, Feb. 22, and March 1, 1907. No. 83617 each D.

Chile.

The Mining Industry in Chile. Henry C. Ede. Information in regard to Chile as a copper and silver producer. 2500 w. Min Jour—March 23, 1907. No. 83420 A.

Cost-Keeping.

Cost-Keeping in the U. S. Reclamation Service. A statement concerning the character of the information which it is desired to obtain, with extracts from the Manual of Field Accounting showing how the methods can be adapted to obtain the results. 3800 w. Eng News—April 25, 1907. No. 83905.

Expense: Manufacturing and Commercial. F. E. Webner. The eighth of a series of articles on cost-keeping. 2200 w. Ir Trd Rev—April 4, 1907. No. 83475.

Jobbing Foundry Cost System. H. D. Miles. Explains a simple and comprehensive system recommended by the Jobbing Founders' Assn. 1400 w. Foundry —April, 1907. No. 83591.

Cost-Systems.

Cost Reduction Through Cost Comparison. C. E. Knoeppel. Third and concluding paper of a series. The present number considers the organization and functions of a cost-reducing department. 4000 w. Engineering Magazine—May, 1907. No. 83940 B.

Exhibition.

Building Trades Exhibition. Describes the principal exhibits at this show at Olympia. 2000 w. Engr, Lond—April 12, 1907. Serial. 1st part. No. 83887 A.

Germany.

The German Engineering Industry in 1906. A review of this past year, which on the whole, was the best since 1900. 1500 w. Engr, Lond—March 22, 1907. No. 83425 A.

Iron Trade.

The Royal Canal Commission and the Iron Trade. Evidence submitted by J. Stephen Jeans for the British Iron Trade Association, before the Royal Canal Commission. 4000 w. Ir & Coal Trds Rev—March 22, 1907. Serial. 1st part. No. 83432 A.

Laboratory.

The New Testing Laboratory at Charlottenburg. Describes this new laboratory at Gross-Litcherfelde, illustrating many of the testing machines employed in testing materials to be used for scientific and commercial purposes. 2800 w. Engr, Lond—March 29, 1907. No. 83552 A.

Municipal Ownership.

The New Orientation of the Municipal Administrations (L'Orientation Nouvelle des Régies Communales). Ernest Brees. Review of Municipal Ownership in Europe and the new system of concession with profit-sharing, its advantages and disadvantages. 12600 w. Rev Econ Inter—March, 1907. No. 83692 E + F.

Oil Industry.

The Future of the Oil Industry in California. Edmond O'Neill. Outlines the past history, and briefly considers the changed conditions, and the problems of transportation, markets for the oil, and related matters. Considers the future outlook bright. 1500 w. Cal Jour of Tech—April, 1907. No. 83953.

Packing.

The Packing of Machinery for Export. W. E. Partridge. An illustrated article describing methods employed successfully in shipping over long routes self-contained machines weighing from 500 to 1500 pounds. 2000 w. Cassier's Mag—April, 1907. No. 83335 B.

Shop Stores.

A Theory of Stores Operation for Machine Shops. H. L. Whittemore. A valuable contribution to the subject of stores keeping, explaining a method which proved useful in a large manufacturing business. 5000 w. Engineering Magazine—May, 1907. No. 83939 B.

MARINE AND NAVAL ENGINEERING

Cable Steamer.

New Japanese Cable Steamer. Particulars of the "Ogasarara Maru," built in Japan. Ills. 2500 w. Elect'n, Lond—April 12, 1907. No. 83873 A.

Cargo Steamers.

The Evolution of the Modern Cargo Steamer. S. J. P. Thearle. Read before the Inst. of Naval Archts. Reviews the development of the modern ocean cargo steamer during the past forty years. The present article discusses the external form and outline, decks, etc. 5800 w. Int Marine Engng—May, 1907. Serial. 1st part. No. 83898 C.

Special Types of Hull Construction for Cargo Steamers. Gives illustrated descriptions of types built in England, showing progress. 2000 w. Eng News—April 4, 1907. No. 83447.

Corrosion.

Corrosion of Steel Boiler Tubes on Vessels Fitted with Turbine Engines. J. Edward Palmer. An account of an interesting case of unusual corrosion caused by copper carried from the bronze turbine blades, by the steam. 800 w. Jour Am Soc of Nav Engrs—Feb, 1907. No. 83770 H.

Cruiser.

Launch of H. M. S. Indomitable. Illustration, account of the launch, and information of this first of three vessels of the same class for the British Navy. 1700 w. Engr, Lond—March 22, 1907. No. 83429 A.

Diesel Motor.

The Diesel Engine for Ship Propulsion (Der Diesel Motor als Schiffsmaschine). R. Gertz. A study of the possibility of using it in large ships. Illus. 2200 w. Schiffbau—Jan. 23, 1907. No. 83610 D.

Docks.

Modern Floating Docks. Lyonel Edwin Clark. Read before the Inst. of Naval Archts. A critical discussion of types now in use. 7000 w. Engng—April 5, 1907. No. 83744 A.

Dry Docks.

The Cavite Dry Dock at Sea. F. M. Bennett. Describes briefly some of the engineering problems that arose while the dock was in transit from the United States to the Philippine Islands. Ills.

5500 w. Jour Am Soc of Nav Engrs—Feb., 1907. No. 83769 H.

The Railway Type of Dry Dock. James L. Crandall. An illustrated article discussing the essential features of a good dry dock, and presenting the advantages of the railway types. 2500 w. Int Marine Engng—April, 1907. No. 83344 C.

Fire Prevention.

The Causes and Prevention of Fire at Sea. Prof. Vivian B. Lewes. Read before the Inst. of Naval Archts. Considers the causes of fires at sea, the safeguards, and means of extinction. 6000 w. Engng—April 5, 1907. No. 83746 A.

Firing.

The Advantages of a Systematic and Regular Method of Working the Fires in a Boiler. R. K. Crank. Remarks on the advantages observed on two trial trips of ships, and gives suggestions for use on vessels where no automatic signals for working fires have been fitted. 1300 w. Jour Am Soc of Nav Engrs—Feb., 1907. No. 83772 H.

Freighter.

The New American Freighter Tuscan. George Jenkins. A single-screw steel freight steamer of the spar deck type, built for the highest class of the American Bureau of Shipping is illustrated and described. 2000 w. Int Marine Engng—April, 1907. No. 83345 C.

Gas Engines.

The Gas Engine for Heavy Marine Service. Lewis Nixon. Gives reasons for its adoption, and a short résumé of what has been done and the outlook. 1200 w. Engineering Magazine—May, 1907. No. 83933 B.

Gyroscope.

The Gyroscope as a Compass. A Frederick Collins. Illustrates and describes the Auschütz gyroscope, designed for the purpose of supplementing the ship's compass. 1100 w. Sci Am—April 6, 1907. No. 83460.

Lifeboat.

An Unsinkable Motor Lifeboat. L. Ramakers. Illustrated description of the "Michael Henry," built by John I. Thornycroft & Co., with report of tests. 500 w. Sci Am—April 6, 1907. No. 83461.

Lighthouse.

Armored Concrete Lighthouse at La Coubre, France. Illustrates and describes the construction of one of the highest light-towers in the world under difficult circumstances, in the short period of nine months. 1600 w. Engr, Lond—April 5, 1907. No. 83747 A.

"Lusitania."

The Cunard Liner "Lusitania." W. J. Luke. Read before the Inst. of Naval Archts. On some points of interest in connection with the design, building and launching of the "Lusitania." 6000 w. Engng—March 29, 1907. No. 83555 A.

Motor Boats.

Motor Boats at the Berlin and Paris Shows (Motorboote auf den Ausstellungen in Berlin und Paris). Auto Nautikus. Description of boats with particulars of the engines. Illus. 4600 w. Zeitschr des Mit Motorwagen Ver—No. 2, Jan., 1907. No. 83602 D.

Nautical Astronomy.

Nautical Astronomy Simplified. Clarence E. Long. Aims to show the usefulness of observing stars for azimuth in ascertaining the deviations of the compass, or for setting the course, giving some useful facts about Polaris and the Big Dipper. 12000 w. Marine Rev—March 28, 1907. No. 83347.

Propellers.

Propeller Struts. George Simpson. Read before the Inst. of Naval Archts. Paper aiming to induce a discussion on a semi-empirical formula, whose function is the determination of suitable dimensions for strut-arms by a definite method. 1500 w. Engng—April 5, 1907. No. 83745 A.

Torque of Propeller Shafting. J. Hamilton Gibson. Read before the Inst. of Naval Archts. Investigations and results of applying the torsion meter to propeller-shafting. 3000 w. Engng—April 12, 1907. No. 83882 A.

Effect of Number of Revolutions and Working Efficiency of Ships' Screws on the Speed (Die Aenderung der Umlaufzahl und des Wirkungsgrades von Schiffschrauben mit der Fahrgeschwindigkeit). H. Lorenz. Mathematical treatment, diagrams. 2700 w. Zeitschr d Ver Deutscher Ingenieure—March 2, 1907. No. 83608 D.

Salving.

The Salving of the Suevic. An illustrated account of the notable salving of this vessel, which was wrecked on the rocks off Lizard Point. 2700 w. Engr, Lond—April 12, 1907. No. 83886 A.

Signaling.

Submarine Signaling. Henry R. Gilson. An illustrated review of the development and the applications made. 2000 w. Elec Rev, N Y—March 30, 1907. No. 83349.

Finding Direction by Means of Submarine Sound Signals. Lucien J. Blake. A mathematical analysis of the sound waves received to determine whether the vessel casts a sound-shadow or not. 1700 w. Elec Wld—April 13, 1907. No. 83718.

Steadying Ships.

Gyroscopic Steadying Apparatus. Sir William H. White. Read before the Inst. of Naval Archts. Gives a summary of results obtained with Dr. Otto Schlick's gyroscopic apparatus for steadying ships, and of the conclusions. Ills. 4500 w. Engng—April 5, 1907. No. 83743 A.

Steamers.

Details of the Three New Steamers Which Will Be Placed on the New York and Boston "Outside" Route by the New England Navigation Company. Profile, sections, and description of important new vessels. 1000 w. Naut Gaz—April 4, 1907. No. 83509.

The River Steamer S. S. Brown. H. H. Brown. Illustrated detailed description of a steel hull, western river packet boat recently built. 2500 w. Int Marine Engng —May, 1907. No. 83896 C.

Steamboating on the Mississippi. Frederick D. Herbert. An interesting illustrated account of the early history of navigation on this river, the types of vessels used, and the recent boats in this service. 2500 w. Int Marine Engng—May, 1907. No. 83897 C.

Submarines.

Safe Submarine Vessels and the Future of the Art. Simon Lake, before the Inst. of Naval Archts. An account of personal experiences and dangers encountered and overcome in experimental work with submarines; a statement of requirements to be met, and of the progress made. Ills. 3500 w. Engr, Lond—March 22, 1907. Serial. 1st part. No. 83431 A.

Tachometer.

Frahm's Resonance Tachometer and Its Use on War and Merchant Ships (Das Frahmsche Resonanztachometer und dessen Verwendung als Umdrehungsfernzeiger für Kreigs und Handelsschiffe). Friedrich Lux. Description of an ingenious electrical device for indicating the speed of a vessel. Illus. Serial. 3 parts. Schiffbau—Jan. 23, Feb. 13 and 27, 1907. No. 83609 each D.

Trials.

Trials of the Lubeck. R. Veith. Reports the trials of the first of the larger turbine ships. 3500 w. Jour Am Soc of Nav Engrs—Feb., 1907. No. 83771 H.

Turbines.

Steam Turbines for Ship Propulsion (Der Dampfturbinenantrieb von Schiffen). Felix Langen. Critical review of a number of turbines in marine service, with comparisons of performances. Serial, unfinished. 5 parts. Schiffbau—Jan. 9 and 23, Feb. 27, March 13 and 27, 1907. No. 83611 each D.

Warships.

The Influence of Machinery on the Gun Power of the Modern Warship. James McKechnie, before the Inst. of Naval Archts. Gives an analysis of the design of all machinery so far as it affects the fighting efficiency of the latest types of warships. Ills. 2800 w. Engr, Lond—March 22, 1907. No. 83430 A.

Wind Pressure.

Suggested Method for Experiments on the Wind Resistance of Ships. F. H. Alexander. Suggests a comparatively inexpensive method whereby some experiments might be carried out to increase the knowledge of the effect of wind's resistance on the vessel's speed. Plates. Also discussion. 3000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1907. No. 83701 N.

MECHANICAL ENGINEERING

AUTOMOBILES.

Africa.

Use of Motor Cars in Africa (Die Verwendung der Selbstfahrer in Afrika). D. Kürchhoff. Discussion of the adoption of motor cars and the number of each kind in use at the present time. 3400 w. Zeitschr des Mit Motorwagen Ver—No. 2, Jan., 1907. No. 83603 D.

Benzine Motor.

Rate of Combustion in Benzine Locomotives (Die Feuergefährlichkeit der Benzinlokomotiven). Herr Beyling. Diagrams. 3800 w. Glückauf—Jan. 26, 1907. No. 83629 D.

Chain Drives.

Chain Drives and Their Care and Repair. Victor Lougheed. Discusses types of chain drives, their advantages and disadvantages, care, repair, etc. Ills. 2000 w. Automobile—April 11, 1907. No. 83572.

Change Gears.

Automobile Change Gears and Their Journals. Henry Hess. Read before Soc. Auto. Engrs., N. Y. The present article discusses a few principles in mounting ball bearings, illustrating a number of gears. 2000 w. Automobile—April 18, 1907. Serial. 1st part. No. 83792.

Couplings.

Universal Joints for Automobiles. E. J. Bartlett. Gives an analysis of the Hooke joint, and description of various types of universal couplings used in autocar construction. Ills. 3500 w. Am Mach —Vol. 30. No. 14. No. 83438.

Farm Work.

Motor Cars for Farm Work (Lastkraftwagen in der Landwirtschaft). A. Oschmann. Specifications and descriptions of working vehicles for farm use. Illus. 7700 w. Zeitschr des Mit Motorwagen Vereins—No. 4, Feb., 1907. No. 83605 D.

Fuel.

A British Motor Fuel. Giving information in regard to benzol, its properties, possibilities and price. 2300 w. Autocar—April 6, 1907. No. 83732 A.

Fumes.

The Smoke Emission Trials. Illustrated description of the competing devices entered for the Vapor Emission Trials, and the tests to which they were subjected. 2500 w. Autocar—March 23, 1907. No. 83408 A.

Heavy Loads.

Motor Cars for Heavy Loads Shown at Paris (Lastautomobile im Pariser Salon 1906). Herbert Bauer. Detailed description of cars for transporting loads of from 3 to 6½ tons. Illus. 5700 w. Zeitschr des Mit Motorwagen Vereins—No. 3, Feb., 1907. No. 83604 D.

Ignition.

How the Magneto is Utilized for Ignition. Charles B. Hayward. Considers the different systems, characteristics of the current, how the time of ignition is altered, etc. Ills. 2000 w. Automobile—April 4, 1907. No. 83471.

Lubricants.

Lubricants for Motors. D. D. B. Glasgow. Discusses the advantages and disadvantages of various lubricants. 2500 w. Autocar—March 23, 1907. Serial. 1st part. No. 83409 A.

Magnets.

The New Lacoste H. T. Magneto. Illustrated description of a high-tension magneto shown at Olympia. 1200 w. Autocar—March 23, 1907. No. 83407 A.

Motor Problems.

Problems of the Motor Industry. Vivian B. Lewes. Abstract of a paper read before the Motor Yacht Club. The present article discusses fuels, especially alcohol. 3000 w. Auto Jour—March 23, 1907. Serial. 1st part. No. 83410 A.

Omnibuses.

Petrol Motor-Omnibuses. W. Worby Beaumont. An illustrated study of these vehicles, the design of the underframes, details of mechanism, etc., and some account of working costs. 12000 w. Inst of Mech Engrs—March 15, 1907. No. 83469 N.

The Darracq-Serpollet Steam 'Bus. An illustrated detailed description. 2200 w. Auto Jour—April 6, 1907. Serial. 1st part. No. 83730 A.

Transmission Gear for Motor Omnibuses (Das Getriebe der Automobil-Omnibusse). Robert Schwenke. Detailed description of transmission used on Daimler and other motor omnibuses. Illus. Serial. 1st part. 1400 w. Zeitschr d Mit Motorwagen Vereins—No. 23, Dec., 1906. No. 83666 D.

Racer.

America's Candidate for the Grand Prix. W. F. Bradley. An illustrated detailed description of the new Christie car. 1500 w. Automobile—April 11, 1907. No. 83571.

Renard Train.

The Renard and Sourcouf Road-Train System. Benjamin H. Thwaite and Richard F. Thorp. Reviews the development of the mechanical road transport system and describes in detail the motor road-train invented by Col. Renard. Ills. 7700 w. Soc of Engrs—April 8, 1907. No. 83790 N.

Shock Absorber.

The Suspension of Industrial Vehicles and Pneumatic Shock Absorbers (La Suspension des Vehicules Industriels et les Amortisseurs Pneumatiques). M. J. Patoureau. Illustrated detailed description of a new pneumatic shock absorber with mathematical discussion of the theory on which they are built. 6000 w. Mem Soc Ing Civ de France—Feb., 1907. No. 83676 G.

Simms-Welbeck.

The 30-35 H. P. Simms-Welbeck Car. Illustrates and describes a six-cylinder car of British manufacture. 2000 w. Autocar—April 6, 1907. No. 83731 A.

Starter.

The Saurer Self-Starter. Illustrated detailed description of a self-starting device invented by Herr Hippolyte Saurer. 1200 w. Autocar—March 30, 1907. No. 83541 A.

Steam Cars.

The Turner-Miesse Steam Car. Illustrates and describes a car of simple construction. 2500 w. Autocar—March 30, 1907. No. 83542 A.

Steam Vehicles.

Steam Motor Wagons at Olympia. Illustrates and describes particulars of some of the steam-operated vehicles shown. 1500 w. Mech Engr—March 23, 1907. Serial. 1st part. No. 83413 A.

Thames.

The 40-50 H. P. Thames Chassis. Illustrated detailed description of the chassis of the six-cylinder Thames car shown at Olympia. 1200 w. Autocar—March 23, 1907. No. 83405 A.

Tyres.

The Interchangeability of Tyres. Information from the principal tyre makers with regard to interchangeability and related subjects. 1800 w. Autocar—March 23, 1907. No. 83406 A.

Wheels.

The Heel of Achilles. G. Stuart Ogilvie.

On resilient wheels in relation to the self-propelled road carriage. 1600 w. Autocar—April 6, 1907. Serial. 1st part. No. 83733 A.

COMBUSTION MOTORS.

Farm Engines.

The Use of Alcohol and Gasoline in Farm Engines. Prof. C. E. Lucke and S. M. Woodward. Discusses the cost of power from different sources, the comparative cost of energy in different fuels, thermal efficiency, adaptability of various types of engines and the first use of alcohol engines in the present number. 4500 w. Sci Am Sup—April 27, 1907. Serial. 1st part. No. 83916.

Fuel.

Some Phases of the Fuel Question. Prof. Vivian B. Lewes. Read before the Inst. of Naval Archts. Discusses the advantages of alcohol as a fuel, comparing the relative values of petroleum spirit and alcohol. 2500 w. Mech Engr—April 6, 1907. No. 83737 A.

Gas Engines.

Gas versus Steam. Louis Illmer, Jr. A comparison of the efficiency, economy and general advantages. 2500 w. Engr, U S A—April 15, 1907. No. 83777 C.

The Dangers of Gas Engines and Methods of Starting (Sui Pericoli dei Motori a Gas ed i Mezzi d'Avviamento). Francesco Massarelli. Discusses the dangers of self-starting engines and the advantages of using compressed air. Ill. Serial. 1st part. 2800 w. L'Industria—March 17, 1907. No. 83680 D.

Automobile Engine Building in a Steam Engine Plant. Illustrates and describes methods of the Providence Engineering Works in the manufacture of about two thousand double-opposed-cylinder automobile gas engines, with the accompanying speed change mechanism, differential gearing, and other related parts. 3500 w. Mach, N Y—April, 1907. No. 83390 C.

Hurd & Haggin Marine and Railway Engine. Illustrated description of a new marine and railway gas engine exhibited at the last Motor Boat Exhibition in New York. 1300 w. Mach, N Y—April, 1907. No. 83391 C.

Gas Producers.

The Utilization of Low Grade Fuel in Gas Producers. F. E. Junge. Discusses the preservation of the fuel supply, the economic features of fuel utilization, the gasification of fuels, and related subjects. 4000 w. Ir Trd Rev—April 4, 1907. Serial. 1st part. No. 83474.

Notes on the Utilization of Poor Coals and Slack. D. B. Dowling. Shows that even the poorest lignite has, as a gas producer, a value equal in power production to that of a good steam coal when used in the steam plant. Discussion. 3000 w. Jour Can Min Inst—1906. No. 83820 N.

Gas Turbines.

Gas Turbines (Les Turbines à Gaz). F. Naive. General details of gas turbine design, their operation, applications, etc. Ill. 2400 w. L'Alliance Industrielle—April, 1907. No. 83686 D.

Gas Washer.

A Stationary Centrifugal Gas Washer. Illustrated description of the Bachman washer, which cleans gas in the same way the Stratton steam separator removes water from steam. 1000 w. Ir Age—April 11, 1907. No. 83557.

Petrol.

The Horse-Power of the Petrol Motor. F. W. Lanchester. Read before the Inst. of Auto. Engrs. Discusses its relation to bore, stroke, and weight, the argument being based on the dimensional theory. 4000 w. Autocar—April 20, 1907. Serial. 1st part. No. 83986 A.

Two-Cycle Engines.

The Two-Cycle Combustion Engine. James McIntosh. Reviews different features capable of improvement, and discusses how to make a success of the two-cycle engine. 2500 w. Ir Trd Rev—April 25, 1907. No. 83960.

HEATING AND COOLING.

Central Plant.

Central Heating System for Fifty-one Detached Buildings. Illustrated description of the central power plant, hot-water heating system and hot-water supply system for the New York Juvenile Asylum, Dobbs Ferry, New York. 2200 w. Heat & Vent Mag—April, 1907. No. 83855.

Modern Methods.

Modern Methods of Heating and Ventilation. A. G. King. The first of a series of articles dealing with this subject in a practical manner. 1800 w. Archts & Bldrs Mag—April, 1907. Serial. 1st part. No. 83774 C.

Refrigeration.

Clearance in a Refrigerating Machine. Oswald Gueth. Calls attention to losses of work in a compressor because of clearance and the effect of the design in curtailing these losses. Ills. 1700 w. Engr, U S A—April 1, 1907. No. 83385 C.

Preliminary Report of the Committee on a Code of Rules for Conducting Tests of Refrigerating Machines. 4500 w. Pro Am Soc of Mech Engrs—April, 1907. No. 83760.

Steam Heating.

Arrangement of Steam Heating Apparatus for Pressure from a Low-Pressure Steam Boiler (Die Anordnung von Dampfheizapparaten innerhalb der Druckhöhe von Niederdruckdampfkesseln). M. Grellert. Diagram and formulae. 3100 w.

Gesundheits Ingenieur—Feb. 2, 1907. No. 83607 D.

Ventilation.

Air, and Its Relation to Vital Energy. S. H. Woodbridge. A comparison between the requirements of mechanical and vital systems, showing the great importance of an adequate supply of pure air. 3500 w. Dom Engng—April 6, 1907. Serial. 1st part. No. 83507.

Ventilators.

Comparison of Recent Ventilators with A. C. Motor Drives and Variable Speed (Vergleichende Untersuchungen an neuern Capellventilatoren mit Drehstromantrieb und veränderlicher Umlaufgeschwindigkeit). R. Goetze. Illus. 2900 w. Glückauf—March 30, 1907. No. 83667 D.

Water Heaters.

Types of Enclosed Steam Water Heaters. C. R. Allensby. Read before the Cic. & Mech. Engrs. Soc. Illustrates and describes the construction of some of the familiar types of heaters. 2500 w. Mech Engr—March 23, 1907. Serial. 1st part. No. 83415 A.

HYDRAULICS.

Pumps.

An Ancient Roman Pump. Illustrates and describes a well discovered in German Lorraine, near the village Sablon. 800 w. Sci Am Sup—April 6, 1907. No. 83464.

Pumping Devices for Open Tank Service. W. H. Wakeman. Illustrates and describes automatic devices for controlling the delivery of water to roof tanks. 1200 w. Sci Am Sup—April 13, 1907. No. 83581.

Turbines.

Large Modern Water Turbine Plants (Grosse moderne Turbinenanlagen). L. Zodel. Description of a 3,000 h.p. station for generating electricity at Verona, Italy. Illus. Serial. 2 parts. 3000 w. Schweizerische Bauzeitung—Jan. 26 and Feb. 2, 1907. No. 83620 each B.

MACHINE WORKS AND FOUNDRIES.

Air Furnace.

The Air Furnace in Grey-iron Founding. Hugh Dolnar. Showing its advantages where it is desirable to obtain uniform mixtures for any work and giving details of a successful furnace. Ills. 1200 w. Am Mach—April 18, 1907. No. 83781.

Armor.

Modern Armor and Armor-Piercing Projectiles. H. J. Jones. The present article describes the manufacture of modern armor plates. 2800 w. Engr, Lond—April 12, 1907. Serial. 1st part. No. 83884 A.

Bearings.

Construction of Conical Roller Bearings. Hugh Dolnar. An illustrated account of the practice at the Timken Roller Bearing Company's shops at Canton, O. 1600 w. Am Mach—Vol. 30, No. 17. No. 83900.

A Fixture Used in Pouring White-Metal Bearings. Charles Prescott Fuller. Illustrates and describes a device carrying a pair of arbors and a series of collapsible bushings around which the metal bearings are run. 3000 w. Am Mach—Vol. 30, No. 16. No. 83780.

Bell Casting.

How Church Bells Are Cast. F. P. Lotz. An illustrated description of the process of bell-founding. 1200 w. Sci Am—April 6, 1907. No. 83459.

Boiler Fittings.

Steel Castings for Boiler Fittings. Abstract of a paper read by Captain Ira Harris at the meeting of the Board of Supervising Inspectors, Steamboat Inspection Service. 2500 w. Boiler Maker —April, 1907. No. 83388.

Brass.

Use of a Block of Wood in Casting Brass for Rolling. Discusses the trouble from the presence of "spills," the cause, and remedy, and the value of the wood block on the surface of the brass in the crucible. Ills. 1200 w. Brass Wld—April, 1907. No. 83927.

Crucibles.

Crucibles—Their Care and Use. John A. Walker. An illustrated article on the keeping and handling of crucibles in a manner that will insure the greatest number of heats with the least danger of accidents. 3000 w. Ind Wld—April 6, 1907. No. 83508.

Cutting Metals.

The Art of Cutting Metals. Contribution to the discussion of paper by F. W. Taylor. 13500 w. Pro Am Soc of Mech Engrs—April, 1907. No. 83762 D.

Drills.

The Thrust of Twist Drills. Henry Hess. Gives a diagram and a formula for thrusts, with remarks. 900 w. Am Mach—Vol. 30, No. 17. No. 83903.

Fly-Wheels.

The Haight Fly-wheel Joint Indorsed. C. H. Benjamin and W. H. Boehm. An illustrated article giving examples showing weakness of fly-wheel joints and suggestions for making the joints as strong as the rims. 2500 w. Am Mach—Vol. 30, No. 15. No. 83560.

Foundries.

Cost of Equipping Foundries for the Manufacture of Open-Hearth Steel Castings. W. M. Carr. Gives an estimate based on the daily capacity. 900 w. Ir Trd Rev—April 11, 1907. No. 83568.

Starting a Foundry. Walter J. May. Suggestions for the proper arrangement and equipment. 2300 w. Prac Engr—April 5, 1907. No. 83734 A.

Design of a Cast Iron Pipe Foundry. J. B. Nau. Drawing and description of some new features in a design made by the writer several years ago. 1300 w. Ir Age—April 4, 1907. No. 83434.

New Plant of the Detroit Steel Casting Company. Illustrated description of a well-equipped foundry for the manufacture of open hearth and converter steel castings. 3000 w. Foundry—April, 1907. No. 83593.

Equipment of Pipe Foundries (Entwicklung der Anlage von Röhrengiessereien). Gustav Simon. Foundry arrangements and devices in use in Austria and Germany described. Illus. 2800 w. Stahl und Eisen—Mar. 20, 1907. No. 83622 D.

Foundry Mixtures.

Fluxes and Alloys. Alexander E. Outerbridge, Jr. Read before the Pittsburgh Found. Assn. Discusses the function of fluxes in the cupola, and their effect upon the melting and properties of pig iron; and a discussion of alloys of metal with cast iron. 4000 w. Ir Age—April 11, 1907. No. 83559.

Galvanized Iron.

The Manufacture of Galvanized Sheet Iron (Fabrication de la Tôle Galvanisée). The Machet machine for galvanizing sheet iron, its construction and operation, and a comparison of this process with ordinary methods. Ill. 4400 w. Mem Soc Ing Civ de France—Feb., 1907. No. 83675 G.

Theory and Practice of Sherardizing. Alfred Sang. Discusses this dry galvanizing process, especially in its theoretical aspects. 3000 w. Elec-Chem & Met Ind—May, 1907. No. 83981 C.

Gas Pipe.

Manufacture of Drawn Gas Pipe (Zur Fabrikation gezogener Gasröhre). Anton Bousse. Description of machines and processes employed. Illus. Serial. 1st and 2d parts. 8000 w. Stahl und Eisen—Mar. 13 and Mar. 20, 1907. No. 83621 each D.

Gears.

Laying Out and Machining Elliptical Gears. Gives the writer's experience in the construction of single-lobe gears. Ills. 1300 w. Am Mach—Vol. 30, No. 14. No. 83439.

Modern Gear-Cutting Machinery. Joseph Horner. Considers present developments in these machines, illustrating and describing special machines of interest. 4000 w. Cassier's Mag—April, 1907. No. 83334 B.

Jigs.

Pneumatic Clamp Drilling Jig. O. C. Bornholt. Illustrated description of a pneumatic clamp drilling jig which was designed for holding small castings, pinions, spur gears, pulleys, etc., for reaming or drilling. 700 w. Mach, N Y—April, 1907. No. 83393 C.

Correcting a Drilling Jig. Walter Gribben and Gus Weinmann. Explains how an accurate job was done with common measuring appliances. 2000 w. Am Mach—Vol. 30, No. 17. No. 83901.

Lathes.

Some Engine-lathe Details. Illustrates and describes details of bed, headstock, and carriage apron. 1000 w. Am Mach—Vol. 30, No. 15. No. 83562.

Motor-driven Automatic Turret Lathe. D. H. Parker. Illustrated description of a machine using automatically controlled variable-speed motors for operating the spindle and cam drum shaft at any desired speed. 700 w. Am Mech—April 18, 1907. No. 83782.

Molding.

Molding a Double Flange Pulley by Machine. C. R. McGohey. Brief illustrated description of a difficult job successfully accomplished. 400 w. Foundry—April, 1907. No. 83592.

A Molding Job with a Green-sand Core. W. W. McCarthy. Illustrates and describes the molding of a newel post for the stairway of the Majestic Hotel, Atlanta, Ga. 1000 w. Am Mach—Vol. 30, No. 17. No. 83902.

Molding Machines.

The Molding Machine in Actual Practice. R. H. Palmer. Considers its adaptability to general work, the percentage of poor castings, and its improvement through co-operation of molders. 4000 w. Am Mach—Vol. 30, No. 14. No. 83440.

Patterns.

Collapsible Patterns. H. J. McCaslin. Illustrates and describes the molding of a surface condenser, as an example of the advantages and possibilities of collapsible patterns. 2500 w. Foundry—April, 1907. No. 83594.

Planer.

A Large Pit Planer. Illustrations, with brief description of a pit planer built for finishing the four edges of armor plate, 24 ft. long by 12 ft. wide by 12 ins. thick at one setting. 700 w. Am Mach—Vol. 30, No. 15. No. 83561.

Press Tool.

A Combination Press Tool for Tin Box Lids. G. Thorne. Illustrated description of a tool used in producing tin lids or caps. 1200 w. Prac Engr—April 19, 1907. No. 83987 A.

Repairing.

Burning a New Jaw on a Heavy Shear. Brief illustrated description of the use of thermit for heating the fractured surface to the fusing point before pouring the cast iron. 500 w. Am Mach—Vol. 30, No. 16. No. 83778.

Screw Cutting.

Gearing Up a Lathe for Screw Cutting. Fred H. Colvin. An explanation of the principle. 1200 w. Ry & Loc Engng—April, 1907. No. 83530 C.

Shops.

The Drop Forge and Hardening Plant. Edward H. McClintock. Illustrates and describes a type of each department, indicating the writer's idea of what constitutes best modern practice. 3000 w. Mach, N Y—April, 1907. No. 83389 C.

Threading Tools.

Measuring Width of Flat on U. S. Standard Thread Tools. Erik Oberg. Explains a method of measuring by a simply designed micrometer, giving tables and diagrams. 1000 w. Mach, N Y—April, 1907. No. 83392 C.

Welding.

Welding and Soldering. Electric Welding Machines for Workshops (Schweissen und Löten. Elektrische Schweissmaschinen für Massenfabrikation). Herr Peter. Description of electric welding apparatus and methods of operation. Illus. Serial. First and second instalments. 6000 w. Glaser's Annalen—Feb. 1 and Feb. 15, 1907. No. 83618 each D.

Works.

Werf Gusto. An illustrated detailed description of these engineering works at Schiedam, Holland, and some of the excavators, dredgers, floating docks and other productions of the firm. 4000 w. Engng—April 5, 1907. Serial. 1st part. No. 83742 A.

Worms.

Making Worms in a Molding Machine. Robert Patten. Half-tones and sketches showing the special devices used in the work. 1100 w. Am Mach—Vol. 30, No. 16. No. 83779.

MATERIALS OF CONSTRUCTION.

lloys.

Light Aluminum Alloys. J. E. Stacey Jones. Abstract of a paper read before the Coventry Engng. Soc. Describes these alloys, their founding and treatment, and methods of testing. 2500 w. Ir & Coal Trds Rev—April 12, 1907. No. 83889 A.

ast Iron.

Tensile Testing of Cast Iron. F. J. Cook. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. Considers characteristics of cast iron in regard to tensile strength. 5500 w. Mech Engr—April 13, 1907. No. 83868 A.

Copper Substitutes.

Substitutes for Copper. Calls attention to the present demand for copper, its high price, and the need of substitution or alloying, and explains the advantages claimed for the Monnot process, especially the copper clad wire. 1400 w. Ir Age—April 4, 1907. No. 83436.

Muntz Metal.

Report on the Decay and Corrosion of Muntz Metal. W. M. Hamlet. Research work to discover the cause of corrosion and decay of this metal, which is an alloy of zinc and copper used for the protection of ships' bottoms against barnacles, seaweed and other forms of marine life. 900 w. Min Jour—April 13, 1907. Serial. 1st part. No. 83877 A.

Rails.

Steel Rails. T. S. Griffiths. Discusses present methods of steel making and the effect on the product, and the causes of inferiority of rails of the present as compared with rails made 10 years ago. 3000 w. Can Engr—April 5, 1907. No. 83505.

Testing.

Brinell's Method for Testing the Hardness of Metals. J. E. Stead and T. Greville-Jones. Description and results of this method, which consists in forcing a hard steel ball into the material to be tested under a given pressure, measuring the depression. 1300 w. Ir & Coal Trds Rev—April 12, 1907. No. 83888 A.

Time-Factor.

The Time-Factor in the Resistance of Materials. Editorial on the effect of the time-factor, referring to recent paper by Mr. Stromeyer. 2200 w. Engng—March 22, 1907. No. 83484 A.

Wrought Iron.

The Structure of Wrought Iron. Albert Sauveur. Gives reproductions of typical drawings and photomicrographs illustrating and describing the structure clearly. 800 w. Elec-Chem & Met Ind—April, 1907. No. 83538 C.

MEASUREMENT.

Comparator.

Mirror Comparator (Comparateur á Miroir). Joseph Rodet. A description of the construction of this instrument for measuring small displacements and a mathematical discussion of its use. Ill. 1200 w. L'Elec'n—March 30, 1907. No. 83691 D.

Shearing Strains.

Shearing Strains in the Material of Rotating Bodies (Ueber die Materialbeanspruchung in rotienenden Körpern). Edmund Röggla. Mathematical treatment. Diagrams. 3000 w. Zeitschr d Oesterr

Ing u Arch Vereines—March 8, 1907. No. 83657 D.

Testing Machines.

Electric Beam Balancing Device for Testing Machines. Illustrates and describes an automatic beam-balancing apparatus devised by G. A. Julius for use in making a large number of tests on the mechanical properties of Australian timbers. 1500 w. Elec Engr, Lond—April 5, 1907. No. 83738 A.

Torsiometers.

Torsiometers as Applied to the Measurement of Power in Turbines and Reciprocating Engines. Archibald Denny. Read before the Inst. of Naval Archts. Illustrates and describes instruments used on turbine engines to determine their efficiency. 2200 w. Mech Engr—April 6, 1907. No. 83736 A.

Turbine Rotors.

The Static Deflection of Turbine Rotors. R. H. Collingham. Shows how, by the aid of graphics, the deflection of any body of varying section, such as a turbine rotor, may be arrived at with a sufficient degree of accuracy for all practical purposes. 2000 w. Engr, Lond—March 29, 1907. No. 83550 A.

POWER AND TRANSMISSION.

Central Plant.

The Central Power Plant at St. Paul's School, Concord, N. H. Plans and description of a plant to furnish heat and light to a group of about 25 buildings. 2800 w. Eng Rec—April 6, 1907. No. 83483.

Cranes.

Cranes for Shipbuilding Berths. Carlo Piaggio. Read before the Inst. of Naval Archts. Gives an illustrated description of the electric cranes at the Riva shipyard. 1000 w. Mech Engr—April 6, 1907. No. 83735 A.

Design and Construction of Electric Overhead Travelling Cranes. Read before the Grad. Assn. of the Inst. of Mech. Engrs. Considers only the multi-motor type with fixed gantry, giving illustrations. 2800 w. Mech Engr—March 23, 1907. No. 83414 A.

The Control of Cranes. E. G. Fiegehen. Discusses in their order the cycle of operations, with suggestions for skilful control. 2500 w. Prac Engr—April 12, 1907. No. 83866 A.

Drive.

A Novel Drive for a Grinding Machine. H. F. Noyes. Illustrated description of a rope drive arranged in an interesting manner for operating the emery wheel of a grinding machine with long bed. 600 w. Am Mach—Vol. 30, No. 17. No. 83904.

Electric Drive.

Motors for Machines and Tools. Dana Pierce. A comparison of the electric drive with the steam drive or water drive by belting and shafting, considering the advantages of the use of electricity in mills and workshops. 2800 w. Ins Engng—March, 1907. No. 83587 C.

Handling Appliances.

Special Handling Appliances for the Shop. H. M. Lane. Illustrates and describes the truck and crane systems of the B. F. Sturtevant Company, Hyde Park, Mass. 2200 w. Ir Age—April 4, 1907. No. 83433.

Power Plants.

Power Plant of the Santa Fe Grain Elevator. Illustrations and brief description of this Chicago plant and the large machinery installation to give great handling capacity. 2000 w. Engr, U S A—April 15, 1907. No. 83776 C.

Power Plant of the Sperry Flour Co., Los Angeles, Cal. W. F. Durand. States the conditions under which the plant must operate, and gives a detailed description of the plant installed, and test results. 3000 w. Eng Rec—March 30, 1907. No. 83367.

Hydro-Electric Power versus Steam for Industrial Plants. H. von Schon. This second article of a series discusses the development of water power as a commercial enterprise. 5000 w. Engineering Magazine—May, 1907. No. 83936 B.

Rope Railway.

A Wire Rope Railway Used in the Construction of an Italian Fortress. Dr. Alfred Gradenwitz. Illustrated description of a ropeway remarkable for its enormous spans and for the great altitude it reaches. 1200 w. Sci Am—April 6, 1907. No 83462.

STEAM ENGINEERING.

Boiler House.

The North Boiler House of Swift & Co. in the Union Stock Yards, Chicago. Illustrated description of a new boiler house having a capacity of 5600 h. p., and its equipment. 4800 w. Eng Rec—April 6, 1907. No. 83480.

Corrosion.

See Marine and Naval Engineering.

Explosions.

The Lap Joint in Boilers. H. S. Brown. Discusses whether lap joints are responsible for boiler explosions. Explains the weak points of lap joints, but states that many troubles have been charged to them for which they are not responsible. Ills. 3500 w. Ir Age—April 18, 1907. No. 83757.

Firing.

Underfeed Firing (Unterschubfeuerungen). A. Pradel. Description of furnaces built for both hand and mechanical underfeed. Illus. 3300 w. Gesundheits Ingenieur—March 30, 1907. No. 83643 D.

Gouy's Theorem.

Gouy's Theorem and Some of Its Applications (Le Théorème de M. Gouy et quelques-unes de ses Applications). E. Jouquet. A mathematical discussion of Gouy's Theorem and of its application to compressed air and steam machines. Ill. 14400 w. Rev de Méch—March 31, 1907. No. 83682 E + F.

Heat.

Heat Power. John Batey. Brief discussion of heat in regard to the steam engine, giving suggestions for increasing the efficiency. 2400 w. Prac Engr—March 22, 1907. No. 83411 A.

Heat Loss.

The Heat Transmission Loss Due to Boiler Scale and Its Relation to Scale Thickness. Gives data and results of tests made at the Engineering Experiment Station of the College of Engineering of the University of Illinois. Also general discussion. Ills. 15500 w. Pro W Ry Club —March 19, 1907. No. 83753 C.

High Temperatures.

Thermal Properties of Water and Steam at High Temperatures. Deals with researches by Prof. C. Dieterici, of the Technical High School of Hanover; and of Prof. Oscar Knoblauch and Dr. Max Jacob of Munich. 2000 w. Engng—March 15, 1907. Serial. 1st part. No. 83466 A.

Mechanical Draft.

Fans for Draft, Forced and Induced. Charles L. Hubbard. Directions for calculating proportions and capacity of fans, the horse-power required, and the volume of air delivered. Diagrams. 2500 w. Power—May, 1907. Serial. 1st part. No. 83861 C.

The Application of the Fan Blower to Mechanical Draft. Carl S. Dow. A discussion of the blower system of forced or induced draft, illustrating some of the fans used. 3500 w. Harvard Eng Jour—April, 1907. No. 83789 D.

Piping.

Troubles Caused by Faulty Piping Work. H. A. Jahnke. Examples of mistakes made by engineers and fitters, and suggestions how to remedy or avoid them. Ills. 2500 w. Power—May, 1907. No. 83862 C.

Smoke.

Smokeless Furnaces and Smoke Suppression. A. Bement. Abstract from the Peabody Atlas, explaining the conditions for perfect combustion and methods of burning fuel. Ills. 2500 w. Engr, U S A —April 1, 1907. No. 83384 C.

Smoke Prevention in Factories and Electric Supply Stations. John B. C. Kershaw. Describes the principles underlying the methods by which fuel may be burned without smoke-production, giving an account of the work of a Smoke Abatement Society. Also discussion. 7000 w. Jour Soc of Arts—March 22, 1907. No. 83404 A.

Steam.

The Economical Generation and Use of Steam. The present articles considers the economy possible in the generation of the steam. 2500 w. Prac Engr—April 12, 1907. Serial. 1st part. No. 83867 A.

Steam Trap.

Testing a Steam Trap at High Pressures. An illustrated account of tests made of a steam trap operating at 375 pounds pressure. 900 w. Engr, U S A—April 1, 1907. No. 83387 C.

Superheating.

Specific Heat of Superheated Steam. A. R. Dodge. Presents two of the methods employed by the writer in making investigations, describing apparatus, and discussing results. Diagrams. 2800 w. Pro Am Soc of Mech Engrs—April, 1907. No. 83761.

Present Practice in the Use of Superheated Steam. Reginald Pelham Bolton. This third and concluding article of a series discusses locomotive and marine applications and superheater design. A bibliography of the contributions to this subject is appended. Ills. 2500 w. Engineering Magazine—May, 1907. No. 83938 B.

Turbines.

Systematic Symbols in Turbine Design (Einheitliche Bezeichnung im Turbinenbau). Olof Linders. A proposed set of symbols for physical properties, energy, etc. 2400 w. Zeitschr f d Gesamte Turbinenwesen—March 20, 1907. No. 83630 D.

Improvements in the Laval Turbine (Die Vervollkomnung der Lavalturbine). Felix Langen. Account of changes in the design of details, to increase the efficiency. Tables. Serial. 3 parts. 5000 w. Zeitschr f d Gesamte Turbinenwesen—March 9, 20. and 30, 1907. No. 83631 each D.

The Curtis Turbine (Die A. E. G. Curtis Turbine). O. Lasche. Comprehensive description of the Curtis turbine as built by the Allgemeine Elektricitats Gesellschaft, for stationary and marine purposes. Illus. 7600 w. Schiffbau—March 27, 1907. No. 83628 D.

Valve Gears.

A New Form of Automatic Assistant Cylinder for Valve Gears. Luther D. Lovekin. Illustrated description of the improved "assistant cylinder" for valve gears designed by the writer. 900 w. Jour Am Soc of Nav Engrs—Feb., 1907. No. 83773 H.

Valves.

Connecting Up Valves. William Kavanagh. Shows some incorrect connections and the means by which they can be rectified. Ills. 1200 w. Elec Wld—April 6, 1907. No. 83502.

MINING AND METALLURGY

COAL AND COKE.

Accounting.

See Industrial Economy.

Alberta.

The Coals and Coal Fields of Alberta, Saskatchewan and Manitoba. D. B. Dowling. A résumé of the extent and character of the coals found in these fields. 2000 w. Can Min Jour—April 15, 1907. No. 83796.

Anthracite.

The North Shaft Mine of the Susquehanna Coal Co., at Nanticoke, Pa. E. E. Winter. Describes the geology of the district, the mining plant and methods of mining, timbering, ventilating, etc. 3000 w. Jour Can Min Inst—1906. No. 83822 N.

Breaker.

Anthracite Breaker of the Pacific Coal Company, Limited, Bankhead, Alberta. Lewis Stockett and B. R. Warden. A description, with drawings and photographs of the building and machinery. 3200 w. Jour Can Min Inst—1906. No. 83817 N.

British Columbia.

Some Notes on the Economic Geology of the Skeena River. W. W. Leach. From the *Jour. of the Can. Min. Inst., Vol X.* Explains the rich possibilities of this region, lacking development for need of transportation facilities. Coal and metalliferous deposits have been located. 4000 w. B C Min Rec—Feb., 1907. No. 83783 B.

Coal Storage.

Under Water Coal Storage. Illustrated description of the arrangements made by the Western Electric Company of Chicago. 600 w. Ry & Loc Engng—April, 1907. No. 83533 C.

Coke.

Coking Freeport Coals in Preston County, West Virginia. J. B. Hanford. Read before the Coal Min. Inst. of America. Explains the development of the process for making these coals into high-grade coke. Ills. 2500 w. Mines & Min—April, 1907. No. 83398 C.

Colliery.

Number Four Pit—Brayton Domain Collieries, Cumberland, England. R. P. Cowen. Prize paper. Illustrated description of methods of mining, timbering, lighting, drainage, etc., at this bituminous coal mine. 2500 w. Jour Can Min Inst—1906. No. 83825 N.

Electric Drive.

Central Electric Drive for Collieries. Franz Erich Junge. Explains the advantages of the central power system for coal mines and coke-oven plants whether steam or gas engines are used. 3800 w. Eng & Min Jour—April 13, 1907. No. 83713.

Essen.

The New Essen and Gelsenkirchen Deposits (Die Neuern Ausschlüsse im Osten der Essener Mulde und des Gelsenkirchener Sattels bis zur Linie Olfen-Lünen). Herr Hilgenstock. A German coal deposit. Illus. Maps. 5300 w. Glückauf—Feb. 2, 1907. No. 83662 D.

Explosions.

Mine Explosions in Illinois. Hon. Richard Newsam. An account of three explosions from excessive use of powder, where neither gas nor coal dust were present. 2000 w. Mines & Min—April, 1907. No. 83401 C.

Wingate Grange Colliery Explosion. Information from the Home Office report of this explosion, which occurred in October, 1906. 5500 w. Col Guard—March 22, 1907. No. 83423 A.

Comments on the Courrières Mine Disaster (Einige Betrachtungen anlässlich der Katastrophen in Courrières und auf Grube Reden). J. Mayer. Serial. 2 parts. 5900 w. Oesterr Zeitschr f Berg und Hüttenwesen—March 16 and 23, 1907. No. 83658 each D.

Explosives.

Explosives in Coal Mines. Report of the Departmental Committee on bobbinite. 7500 w. Col Guard—April 12, 1907. No. 83878 A.

Gas Power.

Economy of Gas Power Plants for Collieries. Franz Erich Junge. Explains the advantages of electric distribution of power from a central gas-engine installation using waste gases and culm. 4500 w. Eng & Min Jour—April 27, 1907. No. 83968.

Haulage.

Endless Rope Haulage. B. Harrison. Gives particulars in regard to the overtub endless-rope haulage of the Silkstone seam at the West Riding collieries. Ills. 2800 w. Min Wld—April 13, 1907. No. 83724.

Kentucky.

Mining in Cumberland Gap Coalfield. John Leggett Pultz. Map, with description of this field, the deposits and methods of mining. 3000 w. Eng & Min Jour—April 27, 1907. No. 83970.

Keps.

Keps. James Tonge. A description and criticism of the best known keps, for supporting cages in winding shafts, used in Great Britain and on the Continent. Ills. 4000 w. Ir & Coal Trds Rev—April 5, 1907. No. 83751 A.

Longwall.

Mining Anthracite by Longwall. Describes an application of the method under conditions rendered difficult by previous working above and below. Ills. 1700 w. Mines & Min—April, 1907. No. 83394 C.

The Effects of Roof Pressures in Longwall Workings. Henry Briggs. Describes methods of taking advantage of them to bring down the coal without blasting. Ills. 3000 w. Mines & Min—April, 1907. No. 83395 C.

Managers.

The Colliery Manager. William D. L. Hardie. Explains some of the present difficulties to be encountered, the information needed, and the wisdom of keeping an index of articles on subjects relating to the work. 4000 w. Jour Can Min Inst—1906. No. 83814 N.

Mine Flooding.

Report on the Inundation of Water at Caradog Vale Colliery. From the Home Office report of this disaster which occurred on June 26, 1906. 2000 w. Col Guard—March 22, 1907. No. 83424 A.

Mine Plant.

Plant of the Berwind-White Coal Company's No. 40 Mine. Illustrated detailed description of an electrical mine plant in Pennsylvania, with modern coal and labor saving equipment. 2500 w. Engr, U S A —April 1, 1907. No. 83383 C.

Ohio.

Methods of Working the Coal Seams of Ohio. Floyd W. Parsons. Illustrates and describes mining in the Hocking Valley field, where an overlying stratum of quicksand makes it impossible to rob pillars and permit the surface to cave in. 2000 w. Eng & Min Jour—April 20, 1907. No. 83840.

Pennsylvania.

Geology of the Buck Mountain Coal Bed. Harry W. Althouse. Describes this formation in Pennsylvania, and the method of working. Ills. 1200 w. Eng & Min Jour—April 6, 1907. No. 83520.

Rescue Apparatus.

Rescue Apparatus at Collieries. Reviews two recent papers by M. Weiss before the Paris Section of the Soc. de l'Ind. Min. relating to the use of rescue apparatus in mines. Ills. 4000 w. Col Guard—March 29, 1907. No. 83549 A.

New Types of Rescue Apparatus in Mines (Nouveaux Appareils de Sauvetage dans les Mines). H. Schwerber. Descriptions of several devices for supplying oxygen to rescuers in mines. Ill. Serial. 1st part. 3000 w. Génie Civil—March 30, 1907. No. 83695 D.

The "Aerolith" Life Saving Appliance (Ueber den Rettungsapparat "Aerolith"). Josef Popper. Description of the Suess patent device for liberating oxygen in gas or smoke-filled places. Serial. 2 parts. 3800 w. Oesterr Zeitschr f Berg und Hüttenwesen—March 23 and 30, 1907. No. 83660 each D.

Testing.

Specific Gravity of Coal as a Measure of Purity. M. S. Hachita. Explains a practical application of this method of testing. 900 w. Eng & Min Jour—April 6, 1907. No. 83521.

Winding Plant.

Electric Winding Plant at a German Colliery. Alfred Gradenwitz. Illustrates and describes the Ilgner system with starting motor and fly-wheel equalizer, as employed at Neindorf. 2500 w. Eng & Min Jour—April 13, 1907. No. 83716.

COPPER.

B. C. Copper Co.

The British Columbia Copper Company's Mines and Smelter. Francis G. Wickware. Gives the history of the development of the company, nature of the ore, geology of the deposit, methods of mining and smelting and detailed description of the entire plant. Ill. 10000 w. Jour Can Min Inst—1906. No. 83821 N.

British Columbia.

The Boundary District, British Columbia. Forbes Rickard. An illustrated description of this district and its ores of the precious metals. 2000 w. Min & Sci Pr—April 20, 1907. No. 83966.

Copper Ores.

Some New Points in the Geology of Copper Ores. James F. Kemp. Read before the Can. Min. Inst. Calls attention to the most productive copper-bearing minerals, showing that recent discoveries have made necessary a change in old views. 2000 w. Min & Sci Pr—March 30, 1907. No. 83442.

Idaho.

The Lost Packer Copper Gold Lode. E. P. Jennings. A description of this remarkable lode, located 25 miles northwest of Custer, Idaho. The ore is chalcopyrite containing from 2 to 20 ozs. of gold and a small amount of silver. 1200 w. Jour Can Min Inst—1906. No. 83803 N.

Mexico.

The Cananea Copper Deposits. Robert B. Brinsmade. An illustrated account of the early discoveries and work, the extent and richness of the ore bodies, and the mining methods. 2300 w. Mines & Min April, 1907. Serial. 1st part. No. 83403 C.

Occurrences.

Some Observations Relative to the Occurrence of Deposits of Copper Ore on Vancouver Island, and Other Portions of the Pacific Coast. William M. Brewer. Gives an outline of the character and extent of these deposits. 3800 w. Jour Can Min Inst—1906. No. 83801 N.

Occurrence of Copper Ore on the North Pacific Coast. William M. Brewer. Information concerning the deposits of copper ore found on the North Pacific coast and adjacent islands. 5500 w. B C Min Rec—Feb., 1907. No. 83785 B.

Ontario.

The Bruce Mines, Ontario, 1846-1906. H. J. Carnegie Williams. An illustrated historical review of these copper mines. 4000 w. Can Min Jour—April 1, 1907. No. 83511.

Production.

The Production and Price of Copper for the Period 1889-1906. John B. C. Kershaw. An examination of the statistics of the world's copper production for the past 18 years, and the future outlook as regards production and price. 2500 w. Elect'n, Lond—April 19, 1907. No. 83994 A.

Queensland.

Cloncurry Copper District. Lionel C. Ball. Notes from a report made recently after inspecting this field. 1200 w. Aust Min Stand—March 27, 1907. Serial. 1st part. No. 83899 B.

Sudbury District.

The Ore Deposits and Geology of the Sudbury District. Hiram W. Hixon. Describes the region and the nickel-copper deposits. Discussion. 5000 w. Jour Can Min Inst—1906. No. 83815 N.

GOLD AND SILVER.

Cobalt.

The Cobalt, Ontario, Camp. From the 1906 report of the Ontario Bureau of Mines. An account of the development and prospecting is given in the present number. 1200 w. Min Rept—April 4, 1907. Serial. 1st part. No. 83522.

The Geology of the Cobalt District. C. R. Van Hise. Believes the ore deposits to have been produced by two concentrations. A study of this district. 1800 w. Can Min Jour—April 1, 1907. No. 83510.

The Bonanza Silver Mines of Cobalt, Ontario. W. Spencer Hutchinson. An illustrated account of the discovery, exploration, and the character of the veins, which are small but rich. 1200 w. Eng & Min Jour—April 27, 1907. No. 83967.

Smelting Cobalt Ores. Hiram W. Hixon. Read before the Can. Min. Inst. Suggests a system of smelting these ores, with the object of inducing the smelting in Canada. 1000 w. Min Wld—March 30, 1907. No. 83379.

Colombia.

The Eocene Gold-Bearing Gravels of Colombia. Francis C. Nicholas. Describes the placer deposits of great wealth which have yielded millions, studying the geological conditions. 2000 w. Min Wld—April 20, 1907. No. 83845.

Colorado.

The Old Hundred Mine and Mill. Illustrates and describes methods of mining huge ore bodies located upon precipitous slopes, and the modern mill and power plant. An illustration of the possibilities of the aerial tramway. 6000 w. Mines & Min—April, 1907. No. 83396 C.

Cyaniding.

Cyaniding Plant for Treating Guanajuato Ores. Carlos W. VanLaw. Illustrated description of plant for treating silver ores. Pulp is transported from the mill to the tanks by a pipe line a mile long. 1200 w. Eng & Min Jour—April 6, 1907. No. 83515.

Cyanide Practice at the Reliance Mill. Douglas Lay. The Hendryx process, agitation, settling and decantation, treating 50 tons of ore per day. Flow sheet. 1200 w. Eng & Min Jour—April 20, 1907. No. 83843.

Last Drainings. H. A. White. A discussion of the possibilities of increased extraction of gold in the South African field. 2700 w. Jour Chem, Met & Min Soc of S Africa—Feb., 1907. No. 83543 E.

Electrolysis of Gold from Cyanide Solutions. Douglas Lay. Describes the method of recovery used at the Reliance mill, at Nelson, B. C., when complete precipitation was obtained by a solution temperature of 70° F. 2500 w. Eng & Min Jour—April 27, 1907. No. 83969.

Dredge.

The Gold-Dredge as a Machine. Discusses the defects of these dredges and the causes of breakdowns and interruption of work. 4500 w. Engr, Lond—April 12, 1907. No. 83883 A.

Hydraulic Mining.

The Government and Hydraulic Mining in California. William W. Harts. An account of the methods of solving the débris problem. Ills. 2000 w. Min Wld—April 6, 1907. No. 83524.

Mexico.

Old Mexican Workings and Some Remarks on Sampling. T. A. Rickard. Illustrates and describes the workings at the Peregrina mine, near Guanajuato, and describes sampling methods. 3000 w. Min & Sci Pr—April 6, 1907. No. 83569.

The Mines of the Altar District, Sonora. John S. Alexander. Map and description of this district, which contains rich placers and ledges. Silver and copper are also mined. 1000 w. Eng & Min Jour—April 6, 1907. No. 83516.

The Parral District, Mexico. F. Lynwood Garrison. An illustrated account of the present condition of this famous silver mining district in the State of Chihuahua. 1800 w. Min & Sci Pr—March 23, 1907. No. 83346.

Nevada.

Mining in the Wonder District, Nevada. Edward R. Zalinski. A report of progress since the first claim was located in April, 1906. The chief value is silver, with from one-fifth to one-eighth in gold. Ills. 1500 w. Eng & Min Jour—April 20, 1907. No. 83844.

The Geology of Goldfield, Nevada. Frederick Leslie Ransome. Abstracted from Bul. U. S. Geol. Surv. Map and description. 3300 w. Min & Sci Pr—April 6, 1907. No. 83570.

The Mines of the Fairview District, Nevada. Edward R. Zalinski. Illustrates and describes a new silver-gold camp in Churchill County, where the chief difficulties are lack of water and a long haul to the railroad. 3300 w. Eng & Min Jour—April 13, 1907. No. 83712.

Nova Scotia.

Gold Mining in Nova Scotia. George W. Stuart. Reviews the causes of the present unsatisfactory condition of gold mining in this province. 1600 w. Can Min Jour—April 1, 1907. No. 83512.

Ore Treatment.

Notes on the Occurrence and Treatment of an Auriferous Ore Containing Insoluble Arsenides. J. K. Wilson. A report of experimental investigations of ores of this class. 3500 w. Jour Chem, Met & Min Soc of S Africa—Feb., 1907. No. 83544 E.

Placers.

Examination of Placer Ground. Regis Chauvenet. Remarks on the importance of a careful testing of the ground in placer mining, and a discussion of the pan as a means of testing are given in the present article. 1800 w. Min Rept—April 4, 1907. Serial. 1st part. No. 83523.

Reduction.

Primitive Mexican Crushing and Dressing Plant. Frank H. Probert. Illustrated description of simple appliances devised centuries ago and still in use in the mountains of Chihuahua. 1200 w. Eng & Min Jour—April 6, 1907. No. 83517.

Slimes.

The Tavener Process of Gold Slimes. L. A. E. Swinney. Notes on the smelting of zinc-gold slimes, representing the actual smelting of a "clean-up" from start to finish of a mine on the Rand. Ills. 2000 w. Eng & Min Jour—March 30, 1907. No. 83354.

Stamp Mills.

More Notes on Stamp Mill Practice. Courtenay de Kalb. Opinions concerning screens, foundations, stamp duty, mortar liners, shoes and dies, amalgamation, etc. 3000 w. Can Min Inst—1906. No. 83805 N.

Tests.

Cyanide Tests on Temiskaming Ores. John J. Robertson. Prize paper. A report of tests made and the conclusions. 1800 w. Jour Can Min Inst—1906. No. 83824 N.

Transvaal.

Politics and the Transvaal Mining Industry. Edgar P. Rathbone. An explanation of present conditions and the outlook for mining. 1600 w. Min & Sci Pr—March 30, 1907. No. 83444.

Yukon.

Recent Developments in Mining in the Southern Yukon. D. D. Cairnes. Explains the conditions under which mining must be conducted, and the general characteristics of this district, describing claims seen, and deposits. 1600 w. Can Min Jour—April 15, 1907. Serial. 1st part. No. 83798.

Note on Windy Arm Silver Bearing Veins. R. G. McConnell. Brief description of a mineral area of promise in the Yukon Territory. The geology, veins and mining development. 1500 w. Jour Can Min Inst—1906. No. 83802 N.

IRON AND STEEL.

Blast Furnaces.

The Effect of Moisture in the Atmosphere Upon the Economical Working of Blast Furnaces. Horace Allen. A discussion of the economical results from drying the blast. 1800 w. Mech Engr—March 23, 1907. No. 83412 A.

The Luermann Cinder Notch. Fritz W. Luermann. Describes disturbances in the working of a blast-furnace, and explains the advantages of the Luermann cinder notch. Ills. 1200 w. Ir Age—April 18, 1907. No. 83756.

The Republic Iron & Steel Co.'s New Furnaces. Illustrates and describes in detail the new Haselton furnace plant at Youngstown, O. 2500 w. Ir Trd Rev—April 18, 1907. No. 83791.

Chrome.

Notes on the Production and Uses of Canadian Chrome. W. H. Edwards. Information concerning the chrome iron found in Quebec, the method of mining and treating the ore, the uses, etc. 1000 w. Jour Can Min Inst—1906. No. 83800 N.

Compound Steel.

Compound Steel—A Modern Steel Plant Proposition. Peter Eyermann. Describes a new process for manufacturing steel, stating its advantages. Ills. 3500 w. Elec-Chem & Met Ind—April, 1907. No. 83539 C.

Corrosion.

The Corrosion of Acid and Basic Steel. Alexander G. Fraser. Synopsis of a paper read before the Iron & Steel Inst. Gives the results of some experiments to determine the relative rates of corrosion. Ills. 1600 w. Ir Age—April 18, 1907. No. 83755.

Electro-Metallurgy.

Some Laboratory Experiments in Making Steel Directly from Iron Ores with the Electric Furnace. J. W. Evans. Illustrates and describes the furnaces used, the methods and results. Discussion. 2500 w. Jour Can Min Inst—1906. No. 83811 N.

Gröndal Process.

Magnetic Separation of Iron Ores by the Gröndal Process. P. McN. Bennie. Read before the Can. Min. Inst. (Slightly abridged.) An illustrated detailed description of this concentrating process. 3800 w. Elec-Chem & Met Ind—April, 1907. No. 83540 C.

Iron Ores.

The Supplies and Reserves of Iron Ores. John Birkinbine. Considers the features which demand attention in determining the probable exhaustion of supplies of minerals. and reviews information available concerning the deposits, discussing improvements in methods which have increased the production. Concludes there is no cause for present anxiety. 5000 w. Can Min Jour—April 15, 1907. No. 83797.

Iron Works.

The Barakar Iron Works of the Bengal Iron and Steel Company. From a paper read before the Min. & Geol. Inst. of India. Describes this plant. 1500 w. Ir & Coal Trds Rev—April 5, 1907. No. 83752 A.

Taganrog Iron Works (Das Hüttenwerk der Metallurgischen Gesellschaft zu Taganrog). L. Fortunato. Description of a large establishment in Russia. Diagram. Serial. 7 parts. 17600 w. Oesterr Zeitschr f Berg und Hüttenwesen—Jan. 5, 12, 19 and 26, Feb. 2, 9 and 16, 1907. No. 83612 each D.

Lake Superior.

The Geology of the Cuyuna Iron Range, Minnesota. C. K. Leith. Describes this district of the Lake Superior region. 2500 w. Ec Geol—March, 1907. No. 83342 D.

Geology of the Ely Trough Iron-Ore Deposits. Clarence E. Abbott. Abstract of a paper read before the Lake Superior Min. Inst. Describes these orebodies at Ely, Minnesota, as replacement deposits inclosed in a greenstone trough under a cap of jaspilite. Ills. 4000 w. Eng & Min Jour—March 30, 1907. No. 83353.

Metallography.

The Microstructure of Steel (Das Kleingefüge des Stahles). H. von Jüptner. Illus. Serial. 1st instalment. 1900 w. Oesterr Zeitschr f Berg und Hüttenwesen—March 30, 1907. No. 83661 D.

Nickel Determination.

The Rapid Determination of Nickel in Steel. Dr. George T. Dougherty. Describes a new method which has a claimed capacity considerably above the standard ether method. 2200 w. Ir Age—April 25, 1907. No. 83913.

Prospecting.

Prospecting for Iron Ore in the Tarbrook Iron District, Annapolis County, Nova Scotia. W. F. C. Parsons. Brief description of the territory, deposits, and development. 1000 w. Jour Can Min Inst—1906. No. 83799 N.

Quebec.

Mining Possibilities in the Province of Quebec. Fritz Cirkel. Deals principally with the development of the magnetic iron resources. 2500 w. Can Min Jour—April 1, 1907. No. 83513.

Salisbury Iron.

The Iron Ores of the Salisbury District of Connecticut, New York and Massachusetts. William Herbert Hobbs. Gives information in regard to the history, geology, distribution and mines of these limonite deposits, discussing their origin. 6000 w. Ec Geol—March, 1907. No. 83343 D.

Steel Works.

The First Electrically Driven Reversing Mill. Illustrates and describes the characteristics of this mill in Austrian Silesia, and the electrical apparatus, and discusses the operating curves. 2800 w. Ir Age—April 25, 1907. No. 83912.

The Gadsden Plant of the Southern Steel Company. Plan, sections, and description of a new plant in Alabama. 2500 w. Ir Age—April 11, 1907. No. 83558.

MINING.

Aerial Tramway.

An Aerial Tramway, Seven Miles in Length (Transporteur Aérien de 35 Kilomètres). Illustrated description of the construction and operation of a long aerial tramway for the transport of ore between Chilecito and Upulungos, Argentine Republic. Ill. 3000 w. Génie Civil—March 23, 1907. No. 83693 D.

Black Sands.

Black Sands of New Zealand, the Pacific, and Tierra del Fuego. C. C. Longridge. An account of the auriferous sands of various sea beaches and the methods of treatment. 3500 w. Min Jour—April 20, 1907. No. 83999 A.

Boreholes.

The Deflection of Boreholes in Diamond Drilling on the Rand. A. Zboril. Discusses the cause of the deflection and means of reducing it. Ills. 3000 w. Jour S African Assn of Engrs—March, 1907. No. 83984 F.

Concentration.

Roasting for Magnetic Concentration of Zinc Ores. Frank H. Trego. A comparison of work of a cylindrical furnace commonly used in southwestern Wisconsin with that of a new circular table roaster. 2500 w. Eng & Min Jour—March 30, 1907. No. 83355.

Drills.

Prospecting Drills. Wallace Dickson. Description and information in regard to drills used with description of an ordinary day's work for a runner or helper. 3000 w. Jour Can Min Inst—1906. No. 83823 N.

Hammer Rock Drills, Particularly those made by Flottmann & Co. (Ueber Hammer-Gesteinbohrmaschinen, insbesondere diejenige von H. Flottmann & Co.) Herr Herbst. Description of Flottmann pneumatic drills. Illus. 2400 w. Glückauf—Feb. 9, 1907. No. 83625 D.

Electrical Winding.

Effects of Acceleration on Winding Torques. George Ness. An account of a test of the Tarbrax electric winding plant showing a variation from 15 to 45 kw. in power taken and 48¼ per cent. efficiency. 1800 w. Eng & Min Jour—March 30, 1907. No. 83356.

Mexico.

Mining and General Progress in Mexico. Manuel Diaz Barriga. Gives information showing the importance of mining in Mexico. 1400 w. Min Jour—March 23, 1907. No. 83422 A.

Peculiar Formations of the Mexican Arid Region. Robert T. Hill. Illustrated description of peculiar formations in desert regions. 4500 w. Eng & Min Jour—April 6, 1907. No. 83519.

Mine Inspection.

The Mine Inspection Service of Pennsylvania. An account of its growth, present organization, and the requirements of the law. 4000 w. Mines & Min—April, 1907. No. 83400 C.

Missouri.

Minerals in Missouri. E. R. Buckley. Information in regard to the minerals of value found in this state and their development. Zinc, lead, and coal are the most valuable. 2000 w. Min Wld—March 30, 1907. Serial. 1st part. No. 83381.

Natural Gas.

Natural Gas Wells and Spring of White River. Arthur Lakes. Illustrated description of the only place in Colorado where natural gas occurs in large volume. 800 w. Min Wld—March 30, 1907. No. 83380.

New Zealand.

The Mineral Resources of New Zealand. James Williams. Second prize essay on the present condition and future prospects of the mineral resources of New Zealand, and the best means of fostering their development. Ills. 35000 w. N Z Mines Rec—Feb. 16, 1907. No. 83863 B.

Ore Milling.

Ore Milling in the Slocan, British Columbia. Philip Argall. From the report of the Zinc Commission of British Columbia. Gives suggestions where the present practice might be improved to save greater values. 2500 w. Mines & Min—April, 1907. No. 83399 C.

Props.

The Use of Steel Props and Girders in Mines. James Ashworth. Information in regard to the styles of props, and the cost of steel as compared with wooden girders in England. 1200 w. Mines & Min—April, 1907. No. 83402 C.

Quarrying.

Slate-Quarrying and Dressing. Edgar J. Scaife. Illustrates and describes the methods employed in Wales in quarrying slate for the purpose of conversion into roofing slates. 1800 w. Builder—April 13, 1907. No. 83864 A.

Safety Catches.

Safety Catches and Safety Brakes. K. Schweder. Outlines the main principles of various catches, and gives a detailed description of a carbonic acid safety brake designed by the writer. Ills. 3500 w. Jour S African Assn of Engrs—March, 1907. No. 83983 F.

Shaft Sinking.

Cement Method of Sinking Shafts in Wet Ground (Einiges über das Zementierverfahren beim Abteufen und Ausbau von Schächten in Wasserreichem Gebirge). Julius Divis. Illus. Serial. 2 parts. 5700 w. Oesterr Zeitschr f Berg und Hüttenwesen—Jan. 19 and 26, 1907. No. 83613 each D.

Siberia.

Siberian Mining Labor. C. W. Purington. Information concerning the classes from which mining laborers come in various parts of Siberia and Russia. Does not think the Russian laborers a very comfortable class to get along with. 1500 w. Min Jour—April 6, 1907. No. 83741 A.

A Brief Sketch of the Lena District, Siberia. C. W. Purington. Map and description of the physical features, geology, and gold-bearing gravels. 2500 w. Min Jour—April 20, 1907. No. 83998 A.

South Africa.

Mining Conditions in South Africa. J. B. Pitchford. A description of present conditions and the methods which make possible a production of $10,000,000 of gold per month from ore giving $8.50 per ton. 1500 w. Min Wld—April 6, 1907. Serial. 1st part. No. 83525.

Winding Engines.

A Comparison of Steam and Electric Winding Engines. Gives the conclusions from a paper by Prof. A. Wallichs, in the

Zeit. des Ver. Deut. Ing. Ills. 1700 w. Engr, Lond—April 5, 1907. No. 83748 A.

Recent Improvements in the Construction of Steam Hoisting Engines (Neuere Erfolge im Bau von Dampffördermaschinen). Ad. Wallichs. Mine hoisting engines described. Illus. Serial. Parts 1 and 2. 2000 w. Oesterr Zeitschr f Berg und Hüttenwesen—March 23 and 30, 1907. No. 83659 each D.

Criticism of Safety Appliances for Steam Hoisting Engines (Zur Kritik neuerer Sicherheitsapparate an Dampffördermaschinen). Herr Hoffmann. Description of safety stops applied to mine hoists, etc. Illus. 5600 w. Glückauf—Feb. 16, 1907. No. 83626 D.

MISCELLANY.

Barytes.

The Barytes Industry of the South. Edward K. Judd. Illustrates a plant in Knoxville, Tenn., for treating barytes, showing that it need not be expensive. 1800 w. Eng & Min Jour—April 20, 1907. No. 83841.

British Columbia.

On Surveys in New Westminster District and Texada Island. O. E. LeRoy. A summary report of the geological survey, the deposits, etc. Ills. 1800 w. B C Min Rec—Feb., 1907. No. 83784 B.

Canada.

On the Advisability of the Establishment of a Federal Department of Mines. H. Mortimer Lamb. Reviews the history of the geological survey of Canada in its relation to the mining industry, and outlines work to be accomplished. 7500 w. Jour Can Min Inst—1906. No. 83807 N.

A Canadian Department of Mines or Geological Survey. J. B. Tyrrell. Considers the duties and uses of such a department. General discussion. 2200 w. Jour Can Min Inst—1906. No. 83808 N.

On the Need of a Topographical Survey of the Dominion of Canada, Particularly with Reference to the Development of the Economic Resources of the Dominion. Frank D. Adams. Shows the need of such a map for the proper development of the country, and outlines the features and advantages of such maps. 5000 w. Jour Can Min Inst—1906. No. 83806 N.

Carbon.

Carbon; a Remarkable Mineral. I. C. Yawger. Interesting information in regard to this mineral, found only in a small section of Brazil. Ills. 3000 w. Min Wld—March 30, 1907. No. 83378.

Chile.

See Industrial Economy.

Diamonds.

The Occurrence of Diamonds in the Drift of Some of the Northern States. Dr. Robert Bell. Discusses the question of the area from which the diamonds have been derived. 1500 w. Jour Can Min Inst—1906. No. 83810 N.

Explosion.

Explosions in the Roburite Works at Witten (Die Explosionen in der Roburitfabrik bei Witten). Dr. Klocke. Diagrams. 2800 w. Glückauf—March 23, 1907. No. 83664 D.

Finance.

Requirements of Modern Mining. J. R. Finlay. Discusses some of the requirements involved in a successful mining business, and the questions to be met in the near future. 2000 w. Min & Sci Pr—April 20, 1907. No. 83964.

Graphic Formulae.

The Use of Graphic Formulae in Metallurgical Calculations. David H. Browne. Read before the Can. Min. Inst. Outlines methods whereby the records of one particular ore may be tabulated and reduced to graphic formulae. 3000 w. Elec-Chem & Met Ind—May, 1907. No. 83978 C.

Igneous Rocks.

A Simple Classification of Igneous Rocks. Scott Turner. Gives a table designed to help in the identification of eruptive rocks, with notes. 1400 w. Min & Sci Pr—March 30, 1907. No. 83443.

Labor.

Mining Labor in Australia. W. J. Loring. Considers the Australian workman superior to any known by the writer in other parts of the world, and gives an account of his characteristics and conditions. 1600 w. Min & Sci Pr—April 20, 1907. No. 83965.

Laboratory Furnaces.

Laboratory Crucible and Muffle Furnaces. George T. Holloway. Describes furnaces that have stood the test of six years' uninterrupted use. Ills. 3000 w. Inst of Min and Met, Bull 31—April 11, 1907. No. 84014 N.

Lead.

Lead Deposits in Northern Kentucky. R. B. Brinsmade. An account of workable lead veins within 50 miles of Cincinnati, O. 1200 w. Eng & Min Jour—April 6, 1907. No. 83518.

Lead Smelting.

A New Matte Separator. R. R. Hedley. Describes a device successfully used in the lead smelting works at Nelson, invented by Henry Harris. Ills. 1200 w. Jour Can Min Inst—1906. No. 83804 N.

Manganese.

Determination of Manganese in the Presence of Tungsten (Ueber die Manganbestimmung bei Anwesenheite von Wolfram). G. von Knorre. 2200 w. Stahl und Eisen—March 13, 1907. No. 83623 D.

Metallurgy.

Physical Chemistry in Metallurgy. Dr. Alex. Findlay. Abstract of a paper read before the Iron & Steel Inst. Shows how physical chemistry explains the laws of the relationships existing between the different structures and their formation. 2200 w. Min Rept—April 11, 1907. No. 83723.

Mexico.

Geology of Sierra Almoloya, Mexico. Robert Thomas Hill. Illustrated description of this range, its geologic structure and mineralization. The ores are valuable for their size and variety, which consist of about equal values in gold, silver, copper, lead, with zinc, iron, and manganese lime flux. 3000 w. Min Wld—April 27, 1907. No. 83975.

Molybdenite.

Molybdenite Deposit in Australia. John Plummer. Describes these deposits and the mining and preparation. Ills. 1600 w. Min Wld—March 30, 1907. No. 83382.

Nickel.

Genetic Relations of Nickel-Copper Ores, with Special Reference to the Deposits at St. Stephen, N. B., and Sohland, Germany. Charles W. Dixon. Briefly reviews the geology of nickel ores in general and discusses the deposits named. Ills. 8200 w. Jour Can Min Inst—1906. No. 83816 N.

On the Nickel Deposits of Webster, Western North Carolina. Alfred E. Barlow. The character and composition of the ore, the geological relations, mode of occurrence, and origin are considered. Ills. 8200 w. Jour Can Min Inst—1906. No. 83819 N.

The Atik-Okan Nickeliferous Pyrrhotite Deposits and Their Origin. F. Hille. A description of the physical features, geology, etc. Ills. 6000 w. Jour Can Min Inst—1906. No. 83818 N.

Oklahoma.

Lead and Zinc Mining. W. R. Crane. A description of the occurrences of ore and methods of mining and milling in the Quapaw district, Oklahoma. 2500 w. Mines and Min—May, 1907. No. 84063 C.

Ore Deposits.

The Relation of Ore-Deposition to Physical Conditions. Waldemar Lindgren. Aims to trace, in a general way, the relations of certain well-known mineral groupings to the physical conditions which there is reason to assume existed during their genesis. 6000 w. Ec Geol—March, 1907. No. 83340 D.

Some Relations of Paleogeography to Ore Deposition in the Mississippi Valley. H. Foster Bain. A study of the relations of sedimentation to ore deposition, especially in connection with the lead and zinc deposits. 5500 w. Ec Geol—March, 1907. No. 83341 D.

Petroleum.

Petroleum in Illinois. H. Foster Bain. Describes the characteristics of these oil-fields in southeastern Illinois. 1200 w. Eng & Min Jour—April 20, 1907. No. 83842.

South Platte Valley.

Topographic Development of Chalk Bluffs and Pawnee Buttes. Junius Henderson. A study of the surface features of South Platte Valley and the relation to underlying deposits of coal, lime, building stone, brick and fire clay, oil and water. Ills. 3000 w. Ores & Metals—April 20, 1907. No. 83856.

Tin.

Cornish Methods of Crushing and Ore Dressing. Edward Walker. A discussion of old and new methods in the dressing of tin ore, and the apparatus used. Ills. 3000 w. Eng & Min Jour—April 13, 1907. No. 83715.

Recent Progress in the Metallurgy of Tin, with Regard to Electrochemistry in 1906 (Fortschritte und Neuerungen in Der Metallurgie Des Zinns, Spoziell in Elektrochemischer Hinsicht im Jahre 1906). H. Mennicke. Review of recent metallurgical processes for the treatment of tin. Serial. 1st part. 2400 w. Elektrochemische Zeitschrift—March, 1907. No. 83669 G.

Yukon.

Yukon Mining Laws. J. B. Tyrrell. Presents some of the main provisions of the laws which have been in force for the past eight years, pointing out their advantages and disadvantages in the working of gold-bearing gravel deposits. 3500 w. Jour Can Min Inst—1906. No 83809 N.

Zinc.

A Study of the Ferrocyanide Method for the Determination of Zinc. W. H. Seamon, in *West. Chem. & Met.* A study of the conditions influencing the determination. 2500 w. Min Rept—April 11, 1907. No. 83722.

Lucky Jim Mine, Slocan District. An expert's description of one of the largest zinc mines in British Columbia. 3800 w. B. C. Min Rec—Feb., 1907. No. 83786 B.

The Valuation of Roasted Blend with Regard to Its Sulphur Content. V. Hassreidter-Trooz. Abstracted from *Zeit. f. angew Chemie.* Gives table showing results of analyses of ten different blendes roasted in six plants, discussing the results. 800 w. Eng & Min Jour—April 13, 1907. No. 83714.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

British Practice in Railroad Accident Inquiries and Railroad Inspection. H. A. Yorke. A statement of British practice with review of the Railroad Acts and legislation, and editorial. 3300 w. R R Gaz—April 19, 1907. No. 83828.

The Recent Accident on the New York Central and Hudson River Railroad. An illustrated account of the Woodlawn accident, discussing its cause. 3700 w. Engng—April 12, 1907. No. 83880 A.

Progress.

Progress in Transportation. G. M. Basford. Extracts from an address before the Tech. Pub. Assn., New York. Remarks on the influence of the railroad on civilization, and especially on the development of the United States. 1200 w. Am Engr & R R Jour—April, 1907. No. 83491 C.

Telpherage.

Branch Railways by the Telpherage System. Illustrates and describes a typical telpherage line, explaining its advantages, cheapness of construction and operation, and its solution of the problem of overcrowded freight lines. 1500 w. Sci Am—April 13, 1907. No. 83577.

Train Lighting.

See Electrical Engineering, Lighting.

Train Tests.

Apparatus for Testing the Handling of Passenger Trains. Frank McManamy. Illustrates and describes a machine for automatically recording all the details of a trip, explaining the charts and the working of the machine. 2800 w. Pro St Louis Ry Club—March 8, 1907. No. 83590.

Trans-Siberia.

Trans-Siberian Ry. Service. From a report by Consul-General Thomas Sammons, of Newchwang, Manchuria, based upon recent personal observations. Information concerning the accommodations and facilities of interest to travelers. 2300 w. Ry & Engng Rev—March 30, 1907. No. 83375.

MOTIVE POWER AND EQUIPMENT.

Brakes.

Defects of New Brake Equipment. G. W. Kiehm. Gives suggestions for cleaning and testing feed valves, and related subjects. 1000 w. Ry & Loc Engng—April, 1907. No. 83531 C.

Cars.

All-Steel Box Cars. A. M. Waitt. Gives a warning against the extensive adoption of these cars for all kinds of service in all climates. Calls attention to the enormous heat accumulated in the sides of steel cars in mid-summer, and the injury to many classes of freight carried, and to cattle, and to other disadvantages. 1300 w. Ry Age—April 12, 1907. No. 83726.

All-Steel Box Cars. Illustrates and describes two cars for the Union Pacific R. R., recently finished at the Omaha shops. 1100 w. Am Engr & R R Jour—April, 1907. No. 83486 C.

All-Steel Postal Car. An illustrated description of a car for the Pennsylvania Railroad, said to be the first absolutely non-combustible postal car ever built. 600 w. Am Engr & R R Jour—April, 1907. No. 83490 C.

All-Steel Pullman Sleeping Car. Illustrated description of a car to be exhibited at Jamestown, which is as near all-metal construction as is now practicable. 600 w. R R Gaz—April 19, 1907. No. 83826.

Electrification.

The Electrification of Steam Railways from the Operating Point of View. As regards ease of operation and continuity of service considers the third-rail system superior to the single-phase overhead system. 2500 w. Elect'n, Lond—March 29, 1907. No. 83548 A.

The Overhead Construction on the Electric Division of the New York, New Haven & Hartford R. R. Foster Hannaford. Brief illustrated description of the trolley wires, the cables from which they are suspended and the bridges which suspend the cables. 1600 w. Yale Sci M—April, 1907. No. 83918 C.

Electric Traction on Railways. Philip Dawson. Considers the various causes which have led to the electrification of railways in the present article. 2500 w. Elect'n, Lond—April 19, 1907. Serial. 1st part. No. 83993 A.

Engine Repairs.

Dispatching Board for Engine Repairs. C. J. Morrison. Describes a board used in the Topeka shops to aid the general foreman in keeping an account of the condition of the work. 600 w. Am Engr & R R Jour—April, 1907. No. 83487 C.

Instruction Car.

New Air Brake Instruction Car. Brief illustrated description of a recently completed car for the C. B. & Q. Ry. representing the latest development. 800 w. Ry Mas Mech—April, 1907. No. 83470.

Locomotives.

Modern Locomotive Engineering in Germany. Charles S. Lake. Gives particulars of the design and proportions of locomotives built in accordance with German ideas at the present time, embracing locomotives for home and foreign service, and for varying classes of traffic. Ills. 1500 w. Mech Engr—March 30, 1907. Serial. 1st part. No. 83546 A.

The Design of Recent English Locomotives. Particulars and illustrations of some of the new engines recently placed in English service. 3500 w. Eng News—April 18, 1907. No. 83890.

Mogul Locomotives for the Isthmian Canal Commission. Gives the principal features in the design of these engines, with illustrations. 300 w. Ry & Engng Rev—April 13, 1907. No. 83729.

Heavy Vandalia Moguls. Illustration, with description of heavy 2-6-0 engines. 600 w. Ry & Loc Engng—April, 1907. No. 83534 C.

Narrow-Gauge Eight-Wheel Duplex Locomotive. Illustrated description of an engine built for a railway of 2 ft. 5½ in. gauge, in the Island of Euboea, designed for large hauling power and suited to sharp curves. 500 w. Engng—April 12, 1907. No. 83881 A.

New Locomotives for the Natural Railway of Mexico. Illustrates and describes Pacific type locomotives recently completed. They comprise 3 simple engines with Richardson slide valve, 1 with Allfree-Hubbell valves and cylinders, and 1 Cole four-cylinder balanced compound engine with Walschaert valve gear. 900 w. Ry Age—April 5, 1907. No. 83536.

New Locomotives for the Cerro de Pasco Ry. Illustrates and describes two engines of the Mikado type and one of the Mogul type built for freight service on a standard-gage road in Peru. 500 w. Ry & Engng Rev—April 6, 1907. No. 83537.

New Type of Great Western Express Engine: An Evolution. Charles Rous-Marten. Introductory remarks on the work of Mr. G. J. Churchward, describing some of his designs, and giving a description of the new type, of which ten are under construction. 3500 w. Engr, Lond—March 29, 1907. Serial. 1st part. No. 83451 A.

Simple Decapod Locomotive. Illustrated description of heavy simple engines for pushing service on the B., R. & P. railroad. 600 w. Am Engr & R R Jour—April, 1907. No. 83488 C.

Tank Locomotive for the Nevada Northern. A heavy tank engine, intended for service between the mines and smelting plant of the Nevada Consolidated Copper Co., is illustrated and described. 400 w. Ry Age—April 12, 1907. No. 83727.

Smith & Perkins, and Their Locomotives. C. H. Caruthers. Drawings, illustrations, descriptions, and general information concerning engines built in Alexandria, Va., between the years 1851-1858. 3500 w. R R Gaz—April 19, 1907. No. 83829.

New Locomotive for the Italian State Railways (Nuove Locomotive delle Ferrovie Italiane di Stato). Description of this four-cylinder compound locomotive. Ill. 2000 w. Il Monit Tech—March 30, 1907. No. 83679 D.

Ten-Wheel Locomotive for the St. Louis and San Francisco. Illustrated description of locomotives fitted with the Walschaert valve motion, worked out so that the motion is carried in a straight line, without offset, from the eccentric crank to the valve stem. 400 w. R R Gaz—April 26, 1907. No. 83923.

Locomotives at the Milan 1906 Exposition (Die Lokomotiven auf der Internationalen Ausstellung in Mailand 1906). R. Sanzin. Description of various types of engines shown, with tables of dimensions, weight, etc. Illus. Continuation of serial; unfinished. 7000 w. Zeitschr d Oesterr Ing u Arch Vereins—March 8, 22 and 29, 1907. No. 83653 each D.

Motor Cars.

Recent Steam Motor Cars in Great Britain. Charles S. Lake. Cars used on the Taff Vale Railway, and the Lancashire and Yorkshire Railway are illustrated and described. 900 w. Am Engr & R R Jour—April, 1907. No. 83489 C.

The Steam Motor Car: Its Value in Interurban Service. W. G. Wagenhals. Read before the Iowa St. & Int. Ry. Assn. Describes a car recently built, explaining the service for which it is intended. 2000 w. St Ry Jour—April 20, 1907. No. 83830.

Valve Gears.

Walschaerts vs Stephenson Gears. W. W. Wood. A discussion of the two valve motions, submitting five propositions bearing on the subject. 2000 w. Ry & Loc Engng—April, 1907. No. 83529 C.

Adjusting Stephenson Valve Gear. **James Kennedy.** Describes methods of careful adjustment. 2000 w. Ry & Loc Engng—April, 1907. No. 83535 C.

Water Purification.

The Purification of Water (Note sur l'Epuration des Eaux). M. H. Boileau. Methods employed to purify boiler-feed water containing sulphur and magnesium chloride by the Phosphate and Railway Company of Gafsa, Tunis (la Compagnie des Phosphates et du Chemin de Fer de Gafsa, Tunisie). Ill. 8000 w. Rev Gen d Chem d Fer—March, 1907. No. 83684 G.

NEW PROJECTS.

Florida.

The Key West Extension of the Florida East Coast Railway. Illustrated description of a remarkable piece of railroad building now in progress from Miami to Key West, Fla. 1500 w. Ry Age—April 19, 1907. No. 83846.

Building the Florida East Coast Extension to Key West. F. E. Spooner. An illustrated article giving information in regard to this interesting work and the labor conditions. 2000 w. R R Gaz—April 26, 1907. No. 83926.

Mexican Central.

The Pacific Extension of the Mexican Central Railway. Describes an important piece of railway construction which will open a new port and give connection between the Pacific and Gulf. 3500 w. Eng News—April 4, 1907. No. 83451.

New Haven.

The Cut Improvements of the New Haven R. R. at New Haven. Outlines the improvements in progress and illustrates and describes interesting features of the work. 2500 w. Eng Rec—April 13, 1907. No. 83706.

New South Wales.

The Great Zig-Zag on the New South Wales Railways. An illustrated description of a scheme to cost £300,000, which will give a new route where traffic can be more easily carried. 500 w. Engr, Lond—March 22, 1907. No. 83428 A.

PERMANENT WAY AND BUILDINGS.

Block System.

Government Report on the Block System. Part of the report sent to Congress Feb. 23, 1907, considering the history, cost, safety, deficiencies, etc. 6500 w. R R Gaz—April 5, 1907. Serial. 1st part. No. 83454.

Coaling Station.

The Coaling Station of the Pennsylvania Railroad at Morrisville. Describes a structure of steel and reinforced concrete. 1000 w. Eng Rec—April 27, 1907. No. 83942.

Construction.

Railway Construction in Difficult Country. Information from report of Henry Deane concerning the construction and operation of railways in mountainous country. 3000 w. Ry & Engng Rev—April 20, 1907. No. 83849.

Costs.

Railway Maintenance of Way. Walter K. Hardt. Discusses the elements that influence the costs of keeping the property up to a proper standard, and the lack of significance of figures as a basis of comparison. 3800 w. Jour of Accountancy—April, 1907. No. 83587 C.

Curves.

The Strain on Curve Spikes. An Abstract of the report of Prof. George F. Swain of computations made in a study of this subject. 2500 w. St Ry Jour—March 30, 1907. No. 83362.

Four-Tracking.

Changing from Double to Quadruple Track (Transformation en Quadruple Voie de la Double Voie de Paris à Creil par Chantilly). M. Rossignol. Illustrated description of the work of tearing down the old masonry overhead crossings without interfering with traffic. Ill. 2200 w. Rev Gen d Chem d Fer—March, 1907. No. 83690 G.

Location.

Economics of Railway Location. Abstract of a report presented at meeting of the Am. Ry. Engng. & Main.-of-Way Assn., with editorial. 4000 w. R R Gaz—April 19, 1907. No. 83827.

Maintenance.

Maintenance of Way. F. O. Dufour. Discusses the permanent way from an economical standpoint, pointing out defects and suggesting remedies. 5500 w. Pro St Louis Ry Club—April 12, 1907. No. 83959.

Rails.

Continuous Rails for Uniform Track Structure. Editorial discussion of the difficulties and conditions, and the appliances to meet the requirements. 1800 w. R R Gaz—April 12, 1907. No. 83573.

Roadbed.

Some Roadbed and Track Standards, N. Y. C. & H. R. R. R. Illustrated detailed description of the construction of the four-track lines. 1400 w. Ry & Engng Rev—April 20, 1907. No. 83848.

Shan Tun.

Construction of the Shan Tun Railway (Vom Bau der Shantung-Eisenbahn). Hermann Meyer. General description of location, permanent way and bridges of a new railway traversing the province of Shan Tun in eastern China. Illus. Serial. 1st part. 2100 w. Deutsche Bauzeitung—Feb. 16, 1907. No. 83634 D.

Shops.

The New Locomotive Repair Shops of the Lackawanna Railway at Scranton, Pa. Illustrates and describes the large modern plant for heavy and light repairs of locomotives which will soon supersede the present shops. 3500 w. Ry Age—April 12, 1907. No. 83725.

Signaling.

Railroad Management and Safety Devices. J. C. Irwin. Deals with the main features of signaling practice at the present time, giving a detailed description of an important installation. 5500 w. Jour Fr Inst—April, 1907. No. 83759 D.

Unsettled Questions in Railway Signaling. W. H. Elliott. Abstract of a paper read before the New England Ry. Club. A discussion of questions closely connected with the operation of block-signal systems. 5000 w. Eng News—April 18, 1907. No. 83891.

Spikes.

Holding Force of Railroad Spikes in Wooden Ties. A report to the U. S. Dept. of Agriculture by W. Kendrick Hatt. Reports tests made to compare the relative holding force of common, channeled, and screw spikes when driven into railroad ties of both hard and soft woods. 1000 w. R R Gaz—April 26, 1907. No. 83924.

Splugen.

The Splügen Railway (Splügenbahn). Description of a new railway and tunnel in the Engadine, Switzerland. Illus. 2300 w. Schweizerische Bauzeitung—March 2, 1907. No. 83633 B.

Stations.

Rearrangement of the Leipzig Stations of the Saxon State Railway. E. Toller. Trans. from the *Organ für die Fert des Eisenbahn.* Explains the conditions that made the work necessary and the changes proposed. 3500 w. Bul Int Ry Cong—March, 1907. No. 83598 E.

New Passenger Station of the Lackawanna at Scranton, Pa. Illustrated description of a fine structure about to be erected. 600 w. Ry Age—April 19, 1907. No. 83847.

Tunnel in Watergraasmeer Sorting Station in Amsterdam (Tunnel im Rangierbahnhofe der Holländischen Eisenbahn—Gesellschaft in Watergraasmeer bei Amsterdam). H. Masereeuw. Mathematical treatment of the design to be executed in concrete. 2300 w. Serial. 1st part. Beton und Eisen—March, 1907. No. 83647 F.

Switzerland.

New Permanent Way of the Swiss Railways (Der Neue Oberbau der Schweizer Bundesbahnen). Fritz Hromatka. Description and specifications for roadbed, rails and steel ties. Illus. 2300 w. Oesterr Woch f d Oeffentlichen Baudienst—March 23, 1907. No. 83645 D.

Terminals.

Chicago & Western Indiana Engine Terminal. Illustrated description of this new engine terminal, made necessary by the work of track elevation at Chicago. 3300 w. Ry & Engng Rev—March 30, 1907. No. 83374.

Ties.

Treatment of Railroad Ties and the Materials Available for this Purpose in New Jersey, New York, and Pennsylvania. L. Bush. A statement of the difficulties of the tie problem, discussing the financial aspect of the situation. 6000 w. Eng Rec—April 20, 1907. No. 83832.

TRAFFIC.

Freight.

Losses and Damages to Freight. Robert L. Calkins. A discussion of freight claims by the freight claim agent of the New York Central. 2000 w. Ry Age—March 29, 1907. No. 83376.

Freight Cars.

The Interchange Use of Freight Cars in North America. W. F. Allen. Reviews the methods of accounting used and the regulations and agreements suggested. 4500 w. Bul Int Ry Cong—March, 1907. No. 83597 E.

The Freight Car Situation. Report of the Committee on Car Efficiency of the American Railway Association. Information gathered and a discussion of what can be done to improve the situation. 3000 w. R R Gaz—April 26, 1907. No. 83925.

Improvements.

Double-Tracking and Yard Improvements to Facilitate Freight Traffic on Railways. Editorial discussion of the freight congestion problem, quoting from recent papers and giving the conclusions reached. 4500 w. Eng News—April 4, 1907. No. 83453.

Rating.

Tonnage Rating. F. W. Thomas. From a paper before the Trav. Engrs. Assn., 1906. Discusses the factors affecting the tonnage hauled. 2500 w. Am Engr & R R Jour—April, 1907. No. 83492 C.

MISCELLANY.

Abandoned Railway.

A Railway in Ruins. An illustrated account of the Shrewsbury, Potteries and North Wales Railway. 2000 w. Engr, Lond—April 5, 1907. No. 83750 A.

Governmental Control.

The Purchase of the Western Railway of France. An editorial review of the conditions governing the relations between the railways and the State in France. 2800 w. Engng—March 15, 1907. No. 83468 A.

Railway Problems.

J. B. Thayer on Railway Problems. Abstract of an address at Buffalo, N. Y. Examines the reasons advanced for the so-called "regulation of railroads." 2000 w. Ry Age—April 26, 1907. No. 83973.

Resistance.

A Study of Train Resistance. J. G. Van Zandt. A study of the conditions of speed and trains that affect the resistance. 4000 w. Wis Engr—April, 1907. No. 83859 D.

Water-Softening.

Railway Water-Softening. An abstract of the more important sections of the report of the Committee on Water Service, presented at the convention of the Am. Ry. Engng. & Main.-of-Way Assn. 2700 w. Eng Rec—April 20, 1907. No. 83838.

STREET AND ELECTRIC RAILWAYS

Electric Locomotive.

Three-Phase Locomotive with Three Ranges of Speed for the Italian State Railways. Bela Valatin. Illustrated detailed description. 2000 w. St Ry Jour—April 6, 1907. No. 83476.

Electric Traction.

Development in Heavy Electric Traction. A series of short papers by prominent men in the electrical and mechanical world on some phases of heavy electric traction. 15000 w. Pro N Y R R Club—March 15, 1907. No. 83754.

Electric Operation of Main Line Railways from an Agricultural and Strategic Standpoint (Der elektrische Betrieb auf Vollbahnen vom wirtschaftlichen und strategischen Standpunkte). Eugen Cserhati. Discussion of the effect of the operation of the Simplon tunnel by electricity as a strategic feature between Switzerland and Italy. Illus. 4200 w. Zeitschr d Oesterr Ing und Arch Vereines—Feb. 15, 1907. No. 83616 D.

Exposition.

Transportation at the Jamestown Exposition. E. C. Hathaway. Explains the plans for handling the large crowds expected. Ills. 900 w. St Ry Jour—April 6, 1907. No. 83478.

Electric Railway Exhibits at Milan, 1906 (Die elektrischen Bahnen auf der Ausstellung in Mailand 1906). A. Zweiling. Illus. Conclusion of serial. 1800 w. Zeitschr d Ver Deutscher Ingenieure—March 16, 1907. No. 83627 D.

Freight.

Freight-Hauling by Electric Lines. P. P. Crafts. Read before the Iowa St. & Int. Ry. Assn. A discussion of matters relating to interurban freight traffic, showing that it can be made successful. 4000 w. St Ry Jour—April 20, 1907. No. 83831.

Interurban.

Some Construction and Operating Features of the Alton, Granite & St. Louis Railway. Illustrated description of a system having a number of overhead railway crossings, and many viaducts. 1600 w. St Ry Jour—March 30, 1907. No. 83358.

The Marion Bluffton & Eastern Railway. An important interurban line, recently completed in Indiana, is illustrated and described. 1200 w. Elec Ry Rev—April 6, 1907. No. 83527.

The Norwich & Westerly Railway. Illustrated detailed description of this high-speed interurban electric railway between Norwich, Conn., and Westerly, R. I. 2500 w. St Ry Jour—April 13, 1907. No. 83703.

The Pittsburg & Butler Street Railway. Illustrated detailed description of a line between the cities named, passing through attractive suburbs of Pittsburg and important oil and coal centers. 4000 w. Elec Ry Rev—April 27, 1907. No. 83974.

Lausanne.

Lausanne Tramways (Les tramways Lausannois). Aug. Wohnlich. Description of the construction and the operative features of the street railways of a modern Swiss city. Illus. Serial. 1st and 2d instalments. 7200 w. Bull Technique de la Suisse Romande—Jan. 10 and Jan. 25, 1907. No. 83606 each D.

Motor Cars.

New 14-Ton Motor Cars, Denver City Tramway. Illustrated description of cars having an especially low weight per unit of seating capacity. 1200 w. Elec Ry Rev—April 6, 1907. No. 83526.

Power Station.

New Power Plant of the Central Pennsylvania Traction Company at Harrisburg, Pa. Illustrates and describes interesting features. 2200 w. St Ry Jour—April 27, 1907. No. 83972.

Rails.

Rail Corrugation. Joseph A. Panton. Gives details of the method of investigation employed by the writer, and the results that formed the basis of his theory that the trouble is due to defects in the rolling-stock. Ills. 5000 w. Inst of Elec Engrs—March 21, 1907. No. 83556 N.

Rapid Transit.

A Continuous Variable-Speed System of Rapid Transit. Illustrated description of a system operated by a continuous screw without motors or transmission and with no risk of collision. 1700 w. Sci Am—April 6, 1907. No. 83458.

Scotland.

Dumbarton Electric Tramways. Illustrated detailed description of these electric lines and their equipment. 2200 w. Tram & Ry Wld—April 4, 1907. No. 83775 B.

Shops.

Car House and Shops at Knoxville, Tenn. Illustrated detailed description of the new buildings and their equipment. 1500 w. Elec Ry Rev—April 13, 1907. No. 83721.

Simplon Tunnel.

The Electric Installations for the Operation and Lighting of the Simplon Tunnel (Les Installations Electriques pour l'Exploitation et l'Eclairage dans le grand

Tunnel du Simplon). E. Rod. The first instalment describes the cables for telegraph, telephone, lighting, signal systems, their construction, laying, etc. Ill. Serial. 1st part. 2500 w. Bull Tech d l Suisse Rom—March 25, 1907. No. 83698 D.

Electric Traction in the Simplon Railway Tunnel. J. B. van Brussel. An illustrated description of this successful installation on the three-phase system. 2500 w. Engineering Magazine—May, 1907. No. 83937 B.

Single-Phase.

Lecture on Single Phase Traction. Abstract of a lecture by W. S. Murray, before the Elec. Engng. Soc. of Columbia Univ., giving information concerning single-phase traction, particularly the method employed by the N. Y., N. H. & H. R. R. in substituting electric for steam locomotives. 1500 w. St Ry Jour—March 30, 1907. No. 83361.

Standardization.

A Claim Agent's View of Standardization. Edward O'Callaghan. An address on the standardization of street railway equipment. 1700 w. St Ry Jour—April 6, 1907. No. 83477.

Subways.

Pittsburgh Subways. E. K. Morse. Explains present conditions in this city and the pressing need of better transit facilities, giving reasons against elevated roads and in favor of underground railways, and discusses the construction, motive power, etc. Also considers subways generally. Ills. and general discussion. 12000 w. Pro Engrs' Soc of W Penn—March, 1907. No. 83702 D.

The Lexington Avenue Subway, New York. Plans and description of this new line about to be constructed. 1500 w. Elec Ry Rev—April 13, 1907. No. 83720.

Subway Station.

Preliminary Construction for the Manhattan Subway Station at Williamsburg Bridge. Illustrates and describes preliminary work for the construction of a station providing for an eight-loop terminal for surface cars and a 620-ft. two-track terminal for elevated trains. 1200 w. Eng Rec—April 27, 1907. No. 83948.

Switzerland.

The Electric Railways and Tramways of Switzerland. W. A. Müller. Translated from *Elektrische Bahnen und Betriebe*. A summary gives particulars of each line, and then considers the results of operating the electric railways and their peculiarities. Map. 7800 w. Bul Int Ry Cong—Feb., 1907. No. 83292 E.

Tracks.

Track Bonding. Thomas B. McMath. Read before the Cent. Elec. Ry. Assn. Brief notes on early methods of bonding, with a description of work in Indianapolis. Short discussion. 2500 w. Elec Ry Rev—March 30, 1907. No. 83363.

Train Control.

A New Multiple Unit System of Train Control. Illustrated description of a new method in use on the Liverpool-Southport electric line. The main feature is the use of solenoid contractors with series, as distinct from shunt, magnets. 2000 w. Elect'n, Lond—April 19, 1907. Serial. 1st part. No. 83997 A.

Turn-Table.

Single Ending Cars with a Novel Turn-Table as Recently Installed by the Public Service Corporation at Hoboken, N. J. Martin Schreiber. Illustrated detailed description of this table and its operation. 1000 w. St Ry Jour—March 23, 1907. No. 83235.

Ventilation.

The Ventilation of Tube Railways. Abstract of a paper by M. C. Birault, read before the Soc. des Ing. Civ. de France. On the Ventilation of Railway Tunnels and Underground Railways. Concludes that very active ventilation is necessary, giving suggestions for securing it. 900 w. Engr, Lond—March 8, 1907. No. 83122 A.

The Ventilation of Railway Tunnels and of City Subways (La Ventilation des Tunnels de Chemins de Fer et des Métropolitains Souterrains). M. C. Birault. An elaborate discussion of the subject with descriptions of methods employed in many European tunnels and subways. Ill. 55000 w. Mem d l Soc d Ing Civ d France—Jan., 1907. No. 83689 G.

The Ventilation and Cooling of the Simplon Tunnel (La Ventilation et la Réfrigération du Tunnel du Simplon). E. Mermier. The first part of the serial describes the methods used to ventilate other similarly-situated tunnels and the first projects for the Simplon. Ill. Serial. 1st part. 2400 w. Bull Tech Suisse Rom —April 10, 1907. No. 83673 D.

Waste Gases.

Waste Gases as a Source of Power for the Operation of Electric Railways. F. E. Junge. A study of the possibilities of utilizing the waste gas energy from iron smelting and coal mining industries for generating electric power. 4000 w. Cassier's Mag—April, 1907. No. 83331 B.

Wheels.

Car Wheels for Interurban and City Service. C. Skinner. Read before the Cent. Elec. Ry. Assn. Brief discussion of wheels for high-speed equipment weighing 40 tons or over per car. Short discussion. 1500 w. Elec Ry Rev—March 30, 1907. No. 83364.

EXPLANATORY NOTE--THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

American Architect. *w*. New York.
Am. Engineer and R. R. Journal. *m*. New York.
American Jl. of Science. *m*. New Haven, U. S. A.
American Machinist. *w*. New York.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w*. Rome.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architectural Review. *s-q*. Boston.
Architect's and Builder's Magazine. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *w*. New York.
Automotor Journal. *w*. London.
Beton und Eisen. *qr*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m*. Bridgeport, Conn.
Brit. Columbia Mining Rec. *m*. Victoria, B. C.
Builder. *w*. London.
Bull. Am. Iron and Steel Asso. *w*. Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bull. Soc. Int. d Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m*. Lawrence.
Bull. Int. Railway Congress. *m*. Brussels.
California Jour. of Tech. *m*. Berkeley, Cal.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *m*. Toronto and Montreal.
Canadian Mining Journal. *b-w*. Toronto.
Cassier's Magazine. *m*. New York and London.
Cement. *b-m*. New York.
Cement Age. *m*. New York.
Central Station. *m*. New York.
Chem. Met. Soc. of S. Africa. *m*. Johannesburg.
Colliery Guardian. *w*. London.
Compressed Air. *m*. New York.
Comptes Rendus de l'Acad. des Sciences. *w*. Paris.
Consular Reports. *m*. Washington.
Deutsche Bauzeitung. *b-w*. Berlin.
Domestic Engineering. *w*. Chicago.

Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Engineering Index.

The Engineering Index Annual for 1906. Size 9½ by 7 in.; pp. 416. Price, $2. New York and London: THE ENGINEERING MAGAZINE.

This volume represents the continuation of the work originally started by the late Professor J. B. Johnson in the Journal of the Association of Engineering Societies in 1884, and turned over by that association to THE ENGINEERING MAGAZINE at the close of 1895. The previous volumes, published respectively in 1892, 1896, 1901, and 1906, covered with increasing care and thoroughness the field of technical engineering periodical literature, and in the present volume every care has been taken to maintain and advance the standard set by its predecessors.

The publication of the quinquennial volumes of the Index was a matter of great labor and expense for which there was no adequate return. It necessitated the entire re-editing of the Index items as they appeared in the pages of THE ENGINEERING MAGAZINE from month to month, a work which required the almost constant attention of a large editorial staff. In view of the limited outlet for the book, this undertaking was not a financial success. Nor was the five-yearly volume entirely satisfactory from the user's point of view. In the rapid increase in technical knowledge and the constant change and development of engineering practice, much of the material indexed was obsolete before the appearance of the book, and, furthermore, searches through the pages of the Magazine between the appearance of one volume and that of the next became a very laborious task. The publication of the Index in annual volumes, therefore, should render it of much greater value to the engineer in placing the information before him while it is still fresh and most likely to be of service.

In the present volume the items are printed as they appeared originally in the Magazine and under the same scheme of classification. While the strictly alphabetical arrangement used in former volumes may be preferred by a certain small class of students, it is probable that the system which has given so much satisfaction to the users of the Index as it appears in the Magazine will meet with the full approval of the average consultant of this volume. The work is divided into eight main sections devoted to, respectively, Civil Engineering, Electrical Engineering, Industrial Economy, Marine and Naval Engineering, Mechanical Engineering, Mining and Metallurgy, Railway Engineering, and Street and Electric Railways. Each of these main divisions is subdivided into several smaller sections, under which the catch-words of the various items are arranged in alphabetical order. The whole object of this plan is to collate for each specialist, the entire current literature of his subject and to assemble it in a small space where it may readily be found and completely explored.

Aside from this detail of arrangement, the work is identical in plan and execution with its predecessors. It presents a complete review of the entire technical press of the world for the year 1906. In it are indexed over 7000 articles of permanent value which appeared in over 250 technical journals, in English, French, German, Italian, Spanish and Dutch. Besides the title and the author's name, there are given in each case, the length of the article in words, the name and date of the publication in which it appeared, and a short *résumé*, indicative of the general scope of the article and prepared by a staff of specialists in the various branches of engineering.

The volume is one which will prove invaluable to any engineer. By no other means can the specialist keep in touch with the development of his particular line in all parts of the world, and to the occasional user it points the way to the latest and best information on any desired subject. To the student also it is indispensable in the proper investigation of any special subject or branch of engineering work. In scope, in thoroughness, and in accuracy it is a work of the highest merit, one which no engineer who wishes to keep up with the development of his profession can afford to be without.

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THE ENGINEERING MAGAZINE.

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AUTHORS AND PAPERS FOR JULY, 1907

JAMES WALLACE VAN CLEAVE *(The True Meaning of the Open Shop)*—Born in Kentucky, 1849, of Dutch ancestry; educated near his home, in Marion County, and in Louisville; began his commercial career in the employ of L. S. Lithgow & Co., stove founders, remaining there seven years and then removing to St. Louis, where he was connected with the Excelsior Manufacturing Co.; in this association traveled widely over the United States; returned to Louisville in 1880 as secretary to the Lithgow Manufacturing Co., successors to the firm with which he was first engaged, and thereafter organized the James W. Van Cleave Co., which later became one of the largest stove concerns in the Southern States. In 1888 was offered the managership of the Buck's Stove & Range Co., of St. Louis, with a substantial interest in the concern, and has since been with them in various capacities—general manager, treasurer, vice-president, and president. During the eighteen years that he has been controlling spirit of this concern he has won the cordial esteem of the employees in office and workshop as well as the high respect of his associates and business acquaintances. He is first vice-president of the Citizens' Industrial Association of America, president of the St. Louis Association, and president of the National Association of Manufacturers.

RODOLPHE MATHOT *(Leading Principles in the Design of Modern Gas Producers)*—A consulting engineer, at present resident in Brussels, Belgium; specialist in gas-producing machinery and gas and other internal-combustion engines; member of the Institution of Mechanical Engineers, of the Société des Ingénieurs Civils de France, etc.; author of the recently published work "Gas Engines and Producer-Gas Plant" (Norman W. Henley, 1905) which received a most flattering introduction from Mr. Dugald Clerk. The present article supplements a preceding one discussing the established principles of gas-engine design.

DEMETRIUS CHARLES BOULGER *(The Railways of the Upper Congo)*—Born 1853; educated at Kensington Grammar School and privately; a student and authority since 1876 on questions concerning the Indian Empire, China, Egypt, and Turkey, and an expert in military questions especially concerning the French frontiers and the position of Belgium; joint founder and for several years editor of the *Asiatic Quarterly Review;* author of many papers and works on Asian questions and contributor to all the leading periodicals on topics within that field.

CHARLES U. CARPENTER *(Profit Making in Shop and Factory Management)*—A graduate of Princeton University with the degrees of mechanical and electrical engineer, has had a large experience in mining engineering and electrical manufacturing and in the supervision of large manufacturing plants; for some years he was factory supervisor and afterwards head of the labor department of the National Cash Register Company, Dayton, Ohio, U. S. A. Later took a similar position with the Herring-Hall-Marvin Safe Company, rising rapidly to the presidency of the concern.

WILLIAM D. ENNIS *(Efficiency in the Burning of Fuel Under the Steam Boiler)*—Apprenticed to the Rogers Locomotive Company; drafting office, Passaic Rolling Mill Company; engine-room, Consolidated Gas Company of New Jersey; engineer of construction, Walworth Construction and Supply Company; designing engineer, Tower and Wallace. From 1901, employed in various engineering capacities in industries personally controlled by Mr. John D. Rockefeller, including the Puget Sound Reduction Company, the Monte Cristo Railway Company, the Everett (Wash.) Pulp and Paper Company, and finally, the American Linseed Company, where he served successively as constructing engineer, chief engineer, and engineer-superintendent. A specialist in power-plant operation: has devoted attention to a constantly increasing extent to the general subject of economical production. A frequent contributor to the technical literature of both subjects. His present series began in the June number of THE ENGINEERING MAGAZINE and will continue for three or four months to come, taking up the burning of small grades of anthracite and the use of powdered fuel.

W. F. CLEVELAND *(The Interchange of Heat in Steam-Engine Cylinders)*—Born in West Clarence, Nova Scotia, 1862, and received his early education there; about 1881 removed with his family to Manitoba and engaged in farming; was always an investigator of engineering subjects, and for twelve years past has been engaged exclusively as an engineering experimentalist; has published many of his studies of the locomotive especially in the *American Engineer, Locomotive Engineering,* the *Scientific American,* etc.

H. VON SCHON *(Hydro-Electric versus Steam Power for Industrial Plants)*—Born in Germany, graduating from Berlin in 1869; for thirty years a specialist in hydraulic engineering; several years were spent by him in connection with the U. S. Engineer Corps in surveys of the Great Lakes, but for the last twelve years he has devoted himself exclusively to the designing of hydro-electric power installations. The most important of the many he has planned is that at the foot of Lake Superior, notable as utilizing the largest flow—some 30,000 second feet—while that at Eugenia Falls, Ontario, uses only 80 second feet, but a head of 400 feet. Mr. von Schon has originated a number of valuable features, one of which, the submerged power house, has been incorporated recently in a plant at Patapsco, Md., the entire generating equipment being placed in the interior of the dam, with the spillway water rolling over the power-house roof. He is a member of the American Society of Civil Engineers. With this issue he concludes his series which began in April, and has discussed the comparative, commercial, structural, and technical aspects of the hydro-electric installation.

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THE
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"THE WORLD IS ITS FIELD"

VOL. XXXIII. JULY, 1907. No. 4.

THE TRUE MEANING OF THE OPEN SHOP.

AN EXPLANATION OF THE PROPOSED CAMPAIGN OF EDUCATION.

By James W. Van Cleave, President of the National Association of Manufacturers.

Mr. Van Cleave's article is written in response to an invitation extended to him by the editors of THE ENGINEERING MAGAZINE a few days after his re-election as president of the National Association of Manufacturers, at its annual convention lately held in New York. Following closely upon the much-noted agreement reached in the British engineering trades, the significant action taken at this convention constituted one of the most important events in current industrial history, but it did not seem to be clearly enough comprehended by the daily press or the public to prevent misunderstanding of the principles it was proposed to advance. The occasion appeared to us opportune for a clear explanation of the stand for the open shop, which is the characteristic plank in the platform drawn at New York, and of the full scope of the campaign in which the Association confidently appeals for the sympathy and approval of the manufacturing world. We are glad indeed, through Mr. Van Cleave's distinguished co-operation, to present so able, authoritative, and appealing a statement of the ideals which underlie this newest and most potentially powerful movement in the economics of American industry.—THE EDITORS.

THE invitation extended to me to prepare this article states concisely the argument for its appearance. There is much misunderstanding by the daily newspapers regarding the "significant action" taken by the National Association of Manufacturers, and especially concerning "the principles which the great fund proposed for the Association was designed to advance." In availing myself of the opportunity to correct this misunderstanding, I cannot begin better than by giving the platform of the Association, which was first formulated in our annual convention of 1903, which has been sanctioned every year, and which may be broadly outlined thus:

1. The open shop.
2. No restrictions as to the use of tools, machinery or materials, except as to such as are unsafe.
3. No limitation of output.
4. No restriction as to the number of apprentices and helpers, when of proper age.
5. No boycott.
6. No sympathetic strike.
7. No sacrifice of the independent workingman to the labor union.
8. No compulsory use of the union label.

The Association, at its convention of May 22, resolved to "instruct its officers to establish and finance a Council to serve as a means of harmonizing and federating the various National and State organizations of citizens, merchants and employers, to the end of utilizing them in a vigorous educational campaign in the interest of industrial peace and mutual good will." I told the convention that I thought that $500,000 a year, or thereabouts, for three years, would be needed to make the work of the proposed council effective. This suggestion received the convention's unanimous approval.

Here is where some of the newspapers erred in interpreting the purpose. They said the $1,500,000 was intended as a war fund by which we aimed to crush the labor unions. Nothing was farther from my thoughts. And I think I am safe in saying that such a thing did not enter the thoughts of any member of the Association which adopted this programme. To show the absurdity of this interpretention of my attitude toward the labor unions, I here give a few extracts from addresses by me in Chicago, Boston, Washington and New York on various occasions in the past few months:

> "Originally the labor unions were called into being by the oppression of some of the employers. In several ways they have done good service to the workers. They have prompted a fraternal feeling and have cultivated a spirit of mutual helpfulness between men in many sorts of occupations. They have aided in advancing the wages of the workers, and thus have obtained for labor a large share of the profits which the co-operation of labor and capital have brought. As fair-minded men we must concede all this. I, for one, have certainly no desire to take away any of the credit belonging to any of the labor unions for any good of any kind which any of them have done."

* * * * * * * *

> "We must recognize the good which is in labor unionism as well as the evil. We must not condemn all the labor unions for the offenses

> of some of them, any more than we would like to have all employers blamed for the shortcomings of a few."
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> * * * * * * * *
>
> "As an ally in combating the extremists who would revolutionize society, abolish the principal incentives for individual exertion, and assail the individual's property and social rights, all good citizens should welcome such co-operation as the labor unions give us. For this reason the employer who would like to strike down all the labor unions indiscriminately is blind to his own interests as well as faithless to his duty to the general public."

Every one of those expressions I repeat emphatically here, and now. In answer to the charge of several papers that I am trying to incite a "war between classes," I here quote a few words from one of my recent addresses in Chicago:

> "The principle upon which the United States Government is founded is equality of privileges and duties for all. Our aim should be to bring employer and employee into fraternal co-operation. Each is necessary to the welfare of the other. If the worker is discontented his usefulness to his employer is diminished, and that employer's interests, social and financial, suffer. The more cordial the feeling which each holds for the other the better for each and for society. The strife between classes and orders which has disturbed Europe for centuries has no place in the social economy of democratic America."

This sentiment I reiterate here. The National Association of Manufacturers, which is itself the largest coalition of employers in the country, asks for a federation of the various organizations of employers throughout the United States for these reasons, chiefly:

1. Defence of our common interests.
2. Political and legislative work.
3. Legal work.
4. The establishment of labor bureaus.
5. Additional organization work.
6. Publicity and education.

In our plan of a federation of all the associations of citizens, merchants and employers of labor in every field, National and State, each organization, while preserving its independence as absolutely as at present, will come into co-operation with all the other organizations in a great council, in which each will have a voice, and in which all will meet on terms of fraternity and equality. Each organization, as now, will deal with the issues affecting itself solely, and the federation, through its council, will handle all the concerns common to all the associations. These concerns are not only large in magnitude but they are large in number. And in number as well as in magnitude they are rapidly expanding. All the organizations represented in the council will go promptly to the defence of any of its members which need assistance. But in order to command this aid the member assailed must be fighting for a principle favored by the council, and be fighting by methods and with weapons which the council recognizes to be just.

The federation's political activity will not be swayed in the slightest degree by party considerations. Many members of Congress and of the legislatures, while honest and conscientious, are timid in dealing with some of the public questions. They are afraid of labor-union assaults at the polls, and in some cases this fear is well founded. When those men represent true Americanism, as did Littlefield of Maine and other congressmen in many states who were attacked by the labor unions in the campaign of 1906, our federation, in the interest of good citizenship, will support them through our literary bureau, on the stump and at the polls.

Littlefield was a Republican, and so were some of the other congressmen who were attacked by the labor unions in 1906 for legislating in the interest of the American people instead of in the interest of the minute fragment of the people comprised in the labor societies. That, however, is a detail in which we would have no concern. Such tags as "Republican" or "Democrat," we will, in our political work, entirely disregard. We will stand up for stalwart Americanism wherever we see it. When we do not see it we will endeavor to create it.

In each State we propose to have a carefully selected committee to look after local legislation in the interest of industry and progress. These committees will report to the council, and will work under the council's direction. We will have National committees, in which all sections and all associations and interests will be represented, to concern themselves with the great questions before Congress, or which ought to be placed before Congress. No lobbying however, will be done by us at any of the State capitals or at the capital of the nation. All improper political methods will not only be shunned by us, but will be assailed by us when employed by others. But every legitimate weapon on which we can lay our hands, through our business, social, and personal connections and affiliations throughout the United States, will be wielded to defeat bad legislation and to promote good legislation.

Under the direction of the council will be a corps of skilled lawyers who will advise local organizations on all legal questions, will report the violation of all State and National laws affecting industry and trade, and, if necessary, will aid the States and the National Government in the prosecution of all offenders against these statutes. An important part of that corps' work will be the prosecution of all labor-union boycotters, picketers, or participants in any assaults on workers, or in any acts of intimidation or coercion.

As shortages and surpluses of labor may exist simultaneously in different localities, we will create labor bureaus in all the country's important industrial centers, and through them the council can operate a labor clearing house by which all such abnormalities can be corrected and a balance established. Through these labor bureaus the council could look after the better distribution of immigrants in the regions in which the chances for their employment are greatest. It could also, through these bureaus, secure picked labor in Europe, so far as this can be accomplished under the immigration regulations and restrictions which go into operation on July 1, 1907, and direct it to the proper localities.

Our ultimate and permanent dependence for skilled labor, however, is in the American boy. This is a fact which I have emphasized in many addresses and in many connections. We must attach a manual-training department to all our public schools of the primary grade, in which boys of 9 or 10 years of age and upward, under competent instructors, can give an hour each day to the use of the tools employed in the more important mechanical trades. This instruction must be free, and should be compulsory. We must have industrial high schools, also free, into which boys of 14 or 15 who have taken the course in the primary schools may enter for advanced and practical instruction, and from which they can be graduated as thorough mechanics. The object of this manual training in the public schools is to supply the need created by the labor unions' virtual abolition of the apprenticeship system, and to supply it in the best possible way and with the best possible material. All the influence of the federation must be used to equip our American boys with a thorough industrial training.

By means of our coalition of all the associations of employers of labor and of all the societies for the cultivation and the extension of good citizenship in the United States, we will raise up a vast body of earnest, public-spirited workers, who will be available in combating every bad issue and cause, and in championing every cause which is calculated to advance the country's prosperity and influence. Knowing that organization for worthy objects incites courage, confidence and enthusiasm, our aim is to extend our organization to the farthest possible extent throughout the country, to cultivate high ideals among our members, and to promote those ideals with all the resources which we can command.

Our principal weapon in all our work will be education and publicity. Let me refer here to something which I said on this point in an address a few months ago.

> "We must, through books, newspapers and public addresses, educate the people, employers and employees alike, and show them their duties as members of society. We must curb the greed of the autocratic employer, point out to the worker that his interest lies in rendering a fair day's service for a fair day's wage, prove that the true relations between capital and labor are those of fraternity and not of war, and that the same incentive for right conduct and the same punishment for wrong-doing presents itself to rich and poor alike. In this way we will diminish strikes and lock-outs, remove all desire on the part of workers for the enactment of anti-injunction laws, and establish an era of industrial peace throughout the country."

These words are taken from an address which I delivered in Chicago recently at the annual convention of the Citizens' Industrial Association of America, of which I am an officer, and of which I was one of the founders. They expressed my idea of the work which, as a national organization, the Citizens' Industrial Association ought to do, and which, in its field, it is endeavoring to do. The St. Louis branch of the Association, of which I am president, has been working along these lines for several years, with very gratifying success.

The work which the Citizens' Industrial Association has been doing in an educational way, and which is being done in a larger field by the National Association of Manufacturers, will be done with far greater resources and on an immeasurably more extensive scale by the federation of organizations of employers and of citizens which we are engaged in forming. Of this federation the National Association of Manufacturers will be the largest member and the nucleus. With us in this federation we expect to get the Citizens' Industrial Association, the Founders, the Metal Trades, the Typothetæ, the Lithographers, and all the rest of the great national organizations of employers and of citizens, and most of the State organizations. For educational purposes--for the education of the employer and the worker alike—we are raising the fund which has aroused the distrust of some of the newspapers.

It will be noticed that I have used the words "industrial peace" in many places in this article. I have done this because the words express, with precision, our purpose in forming the federation, and in raising the fund through which the federation will do its work. The words are not employed by me in any ironical or sinister sense. We are not proposing to create a solitude and call it peace. Nor do we, as a preliminary to an attack on the labor unions, cry peace, peace, when there is no peace. As I use the word peace in this article and in the other connections in which I have employed it, the word carries the plain American meaning which will be found in any of our dictionaries, without any reservations, qualifications or emendations of any sort.

I wish to call the attention of our good friends of the daily press to what I have just said, and to what I am about to say. The federation and its fund will work for peace and not for war. I wish also to call their attention to the fact that the resolution of the convention of the National Association of Manufacturers which declared in favor of the federation expressly set forth that the federation and the fund which would finance it are for the purpose of making a "vigorous educational campaign," and for making it "in the interest of righteous industrial peace and of mutual good will."

The peace which will produce "good will" between employers and workers must necessarily be "righteous." No other kind of a peace would satisfy both sides. No other sort of a peace would stick. We seek a peace which will be permanent. If possible, we want to do the work of peace-making so well in 1907, 1908, or 1909 that neither we nor any of our successors will find it necessary to do the work over again in 1910, 1915, or ever.

We have selfish as well as moral reasons for wanting industrial peace. The moral reasons appeal to all good citizens alike—to all who love their fellow men, and who wish to see their country made prosperous and powerful. The selfish reasons appeal to us as business men who want stability in the labor market, who want to be able to make contracts with our workers which will last, who want to lengthen the country's lead in the great industrial activities, and who aim to equip ourselves to meet the competition which our European rivals are putting up for us in the markets of the world.

Our propaganda will not be against labor unionism as such, but against the vicious practices which have fastened themselves on some of the unions—the practices which embody themselves in the public mind when the names of such leaders as Sam Parks, Debs, Martin Irons, Shea, and Schmitz are mentioned. In this age of concentration and consolidation in all activities, industrial and social, the workers have as good a right to organize as have the employers. A majority of the members of the labor unions are good men. Some of them are among the worthiest of the country's citizens.

In our campaign of education we will aim to strengthen the hands of these members of the unions, so that they can overthrow such corrupt and incapable officers as they may have, and replace them by conservative and progressive men. Our work will be carried on among the employers also. We are against industrial oppressions, regardless of whether the oppressors are employers or employees. Monopoly of all sorts, in the form of capitalistic trusts as well as of labor trusts, we will combat.

Believing, with Jefferson, that error is never dangerous so long as truth is free to combat it, and has at the same time the spirit and the facilities to combat it, we will fight ignorance with education, narrowness and blindness with enlightenment. We will fight demagogism, socialism, anarchism and all things that pretend that the rich are the enemies of the poor, that seek to establish class lines and incite class hatreds in the community, and that raise their hands against the Government and the social order.

Under the direction of the council, in which all our organization, National and State, will have a voice, and which will order and supervise all the Federation's activities, we will have a literary bureau and corps of writers and lecturers. These persons, men and women, will be selected with regard to their education and their fitness for the particular tasks to which they are assigned, as well as with regard to their zeal for their work, and their determination to make it effective.

We propose to shape our instruction to the environment, the capacity, and the prejudices of the elements which are to be reached. Through the regular daily and weekly papers and the magazines, through our own publications, and from the platform and the pulpit, we shall preach the gospel of peace between rich and poor, between capital and labor, between employer and worker. In this way we will take away some of the audiences from the demagogue and the destructionist, and diminish their power to make mischief. We may not, and probably will not, abolish all industrial wars, for human weaknesses and follies cannot be eradicated in a year or a century by any sort of agencies which can be devised; but we have faith that we can and will make the industrial wars fewer and far less destructive than they are now.

GAS AND ELECTRIC POWER IN CONTINENTAL IRON AND STEEL WORKS.

By J. B. van Brussel.

The huge order for the installation of gas engines which, it is announced, has been issued by the United States Steel Corporation, suggests that American steel making is at last to be characterized by some of the economy of resources and operation which has so long been sought on the Continent. The principal features of modern European practice were summarized in our March number as furnace-gas utilization, by-product coking, and electric driving. Mr. Cuntz's article at that time considered chiefly the former two, while Mr. van Brussel takes up more in detail the last-named of these movements.—THE EDITORS.

PRESSURE of competition, and modest endowment in natural resources, early forced the iron masters of Europe to a study of economy unnecessary in the richer Western World. Now that even the lavish American steel industry is showing a disposition to turn from extensive to intensive cultivation, it is of interest to review some of the most important economies which have been applied in Europe in the manufacture of iron and steel, beginning with the ore and following the various processes through to the finished product.

As a general rule, every important works using electricity has its own electric-power generating station. This is usually equipped with either reciprocating-engine generating sets, steam-turbine sets, or gas-engine sets. Steam-driven plants until within the last four or five years were almost exclusively of the type first-named. The recent development in steam turbines and turbo-generators has, however, brought forward this method of generating as a competitor to the steam engine, more particularly in the case of large units. Where blast-furnace gas is available, the argument for the use of gas engines is strong, since power can be generated by this means at considerably less cost than by burning the blast-furnace gas under boilers.

The illustration, Figure 1, gives a view of the central station of Ilseder Steel Works, at Peine, near Hannover (Germany). This station now comprises two Ochelhäuser-Siemens-Schückert gas-engine generating sets, having each a capacity of 1,000 horse power, three-phase, 10,000 volts, 50 periods, 125 revolutions per minute. The engines are driven by blast-furnace gas; the station is to be extended by the installation of two more sets, each of 1,600 horse-power

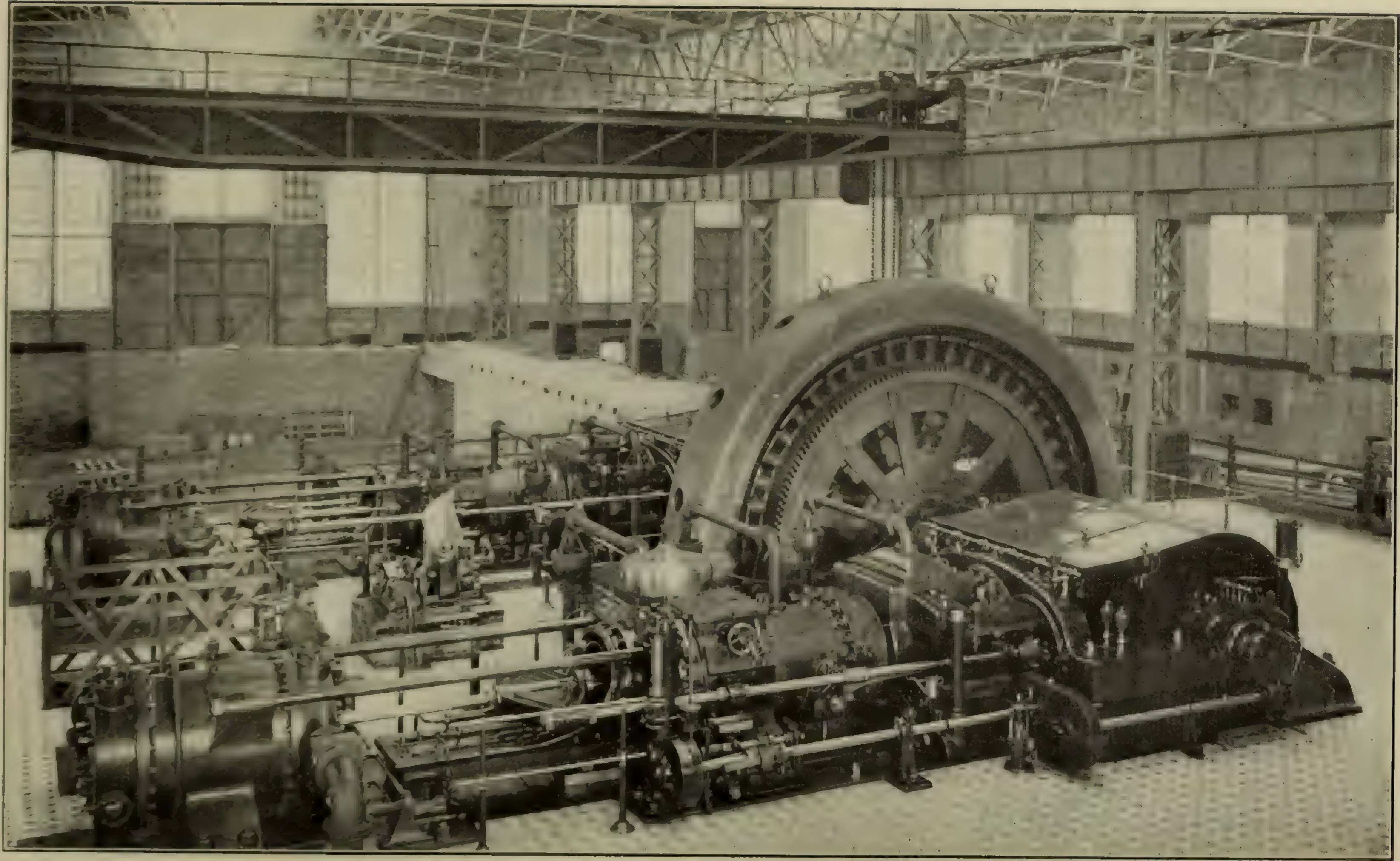


FIG. I. ONE OF THE OCHELHÄUSER-SIEMENS-SCHÜCKERT GAS-ENGINE GENERATING SETS, CENTRAL STATION OF THE ILSEDER HÜTTE, AT PEINE.

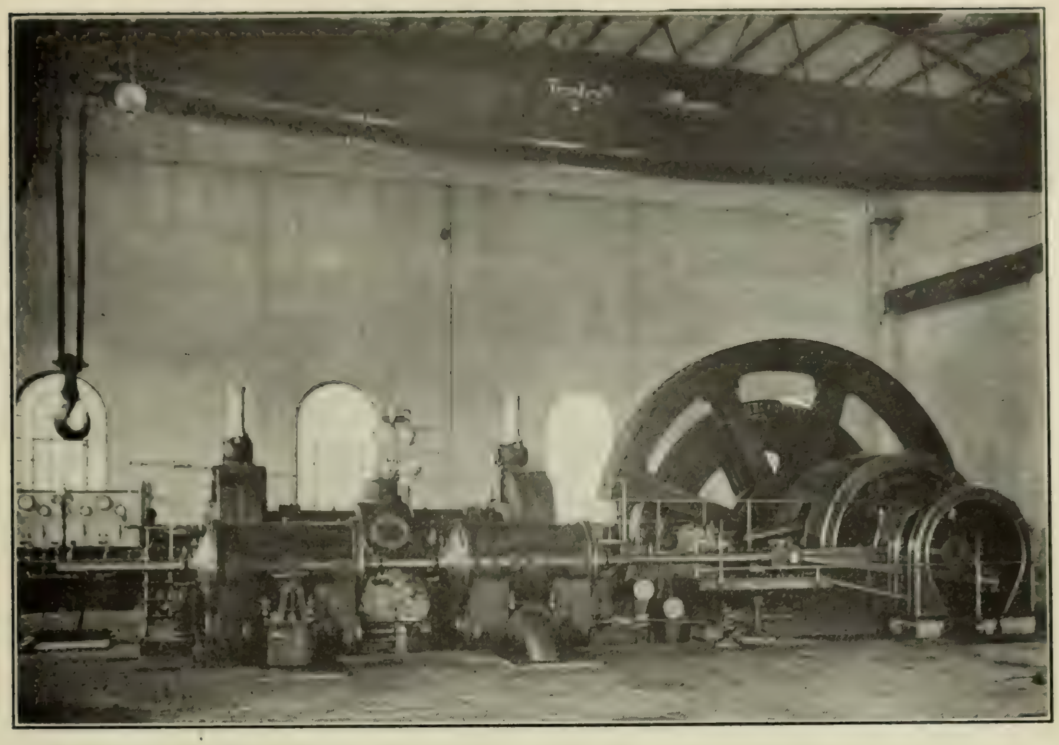


FIG. 2. A KÖRTING-SIEMENS-SCHÜCKERT GAS-ENGINE SET, CENTRAL STATION OF THE GUTEHOFFNUNGSHÜTTE, OBERHAUSEN.

capacity. Figure 2 shows one of the three Körting-Siemens-Schückert gas-engine sets in the power station of the Gutehoffnung Works, Oberhausen (Germany). Each set has a capacity of 1,000 horse power, three-phase, 3,000 volts, 71 revolutions per minute. There are also several other gas engines in the station, all of which are driven by blast-furnace gas. The station supplies power for an 1,800 horse-power motor driving a plate mill, a 1,500 horse-power motor driving a bar mill, an 1,800 horse-power motor driving a rail mill, and about 1,500 horse power distributed among various motors for driving live-rolls, pumps, and auxiliary machinery about the steel mill.

Electric motors are now extensively employed for driving blast-furnace hoists. For this purpose it is necessary that the motors should start frequently and that some form of starting gear be provided which can be readily controlled from a distance. Starters driven by pilot motors or with solenoids for actuating the different contact steps have been used, but they have the disadvantage that considerable power is lost in resistance at each start. There is also some difficulty with this method in arranging for the cage to stop exactly at the right level so that the trucks may be conveniently wheeled off. To accomplish this result a method of control must be adopted which permits of gradually retarding the hoist until a very low speed is

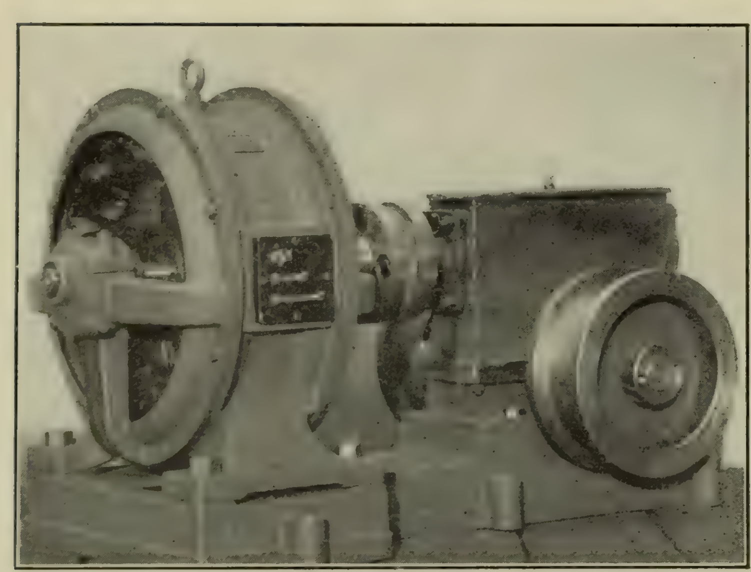


FIG. 3. STANDARD WINCH FOR HANDLING BLAST-FURNACE BELLS.

reached, the current being finally broken and a holding brake applied at the exact instant when the cage arrives at the floor level. The most perfect method of accomplishing the above result, and also of saving practically all rheostatic loss at the beginning of each hoist, is to use a motor-generator running constantly, the armature of the generator being connected in series with the armature of the hoist motor. The field of the generator is controlled by a small rheostat placed conveniently for the operator, by means of which a varying voltage is applied to the armature of the hoist motor. In this way the speed of the hoist motor is controlled by moving the rheostat handle, the speed being dependent upon the position of the handle. The rheostat is best placed on the hoist guides in a position convenient for operating, and to the cage are fixed cams, which automatically shut off the rheostat and gradually reduce the speed of the cage as it approaches the floor level. At the exact instant that the cage reaches the floor level, a raised portion of the cam forces the rheostat handle to the "off" position, thus entirely breaking the circuit and at the same instant applying a holding brake. The cams also prevent the cage being accelerated too rapidly when starting. This method is very simple and reliable, and requires no skill whatever on the part of the operator. The first cost of the installation is somewhat increased but its advantages amply justify the slight extra investment.

No method of absorbing the energy of the moving masses in mechanical brakes will be found satisfactory for stopping a cage at a fixed point, as even small changes in temperature of the brake will vary the distance run by the cage. An amplification of the voltage-control method described above is to provide a small flywheel direct coupled to the motor-generator. The method of control remains the same, but the introduction of the flywheel serves to equalise the load and reduce the demand upon the generating station at the beginning of each hoist. Figure 3 shows a simple form of motor-driven winch for operating blast-furnace bells. The winch consists of two drums, which are driven through worm-gearing by a motor of either the three-phase or continuous-current type. The wire rope which actuates the mechanism for moving the bell is divided where it passes over the drums into two ropes, each of which makes one turn about one of the drums. By thus dividing the rope, a smaller diameter of drum is permissible. The rope after leaving the drum is connected to a counterweight. By starting the motor in one direction, the bell is lowered until its further motion is limited by a stop. The motor may then continue to revolve, but as the rope on leaving the drum becomes slack through the weight of the bell being taken by the stop, slipping between the rope and drum occurs and the counterweight is lifted no higher. Upon reversing the motor the bell is closed, and at this instant the counterweight is also brought against a stop. The rope is thus slackened where it leaves the drum and the motor is again free to continue running, the rope slipping on the drum. By this simple means, overloading of the motor and complicated gear for stopping it at exactly the right instant are avoided. In the case of three-phase motors, a simple reversing switch, as shown in Figure 4, is used, and a small resistance is connected permanently in the circuit of the rotor. For continuous-current motors a small reversing controller is employed. Motors for driving the blowers for blast furnaces have also been used in some cases, though their application is as yet limited. Electric motors have further been used to a considerable extent for tipping Bessemer converters. The problem presents no special constructional difficulties, and standard motors and controlling apparatus are adapted for this purpose. For driving

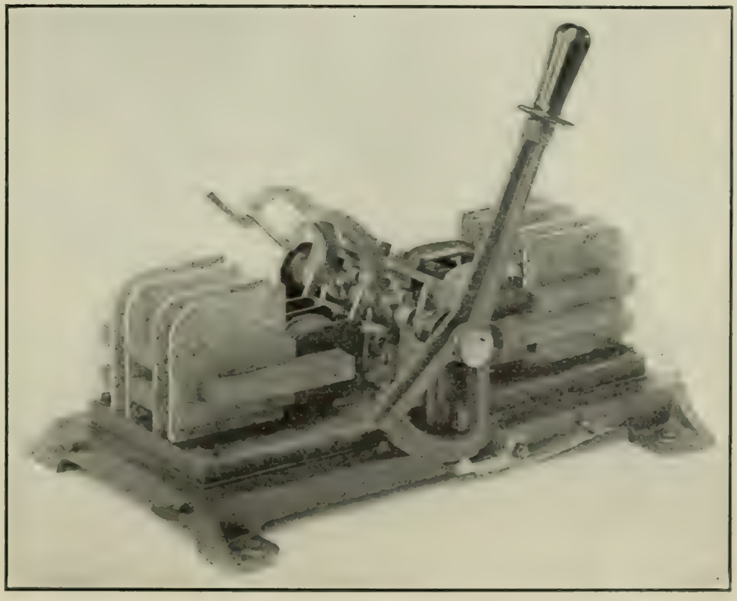
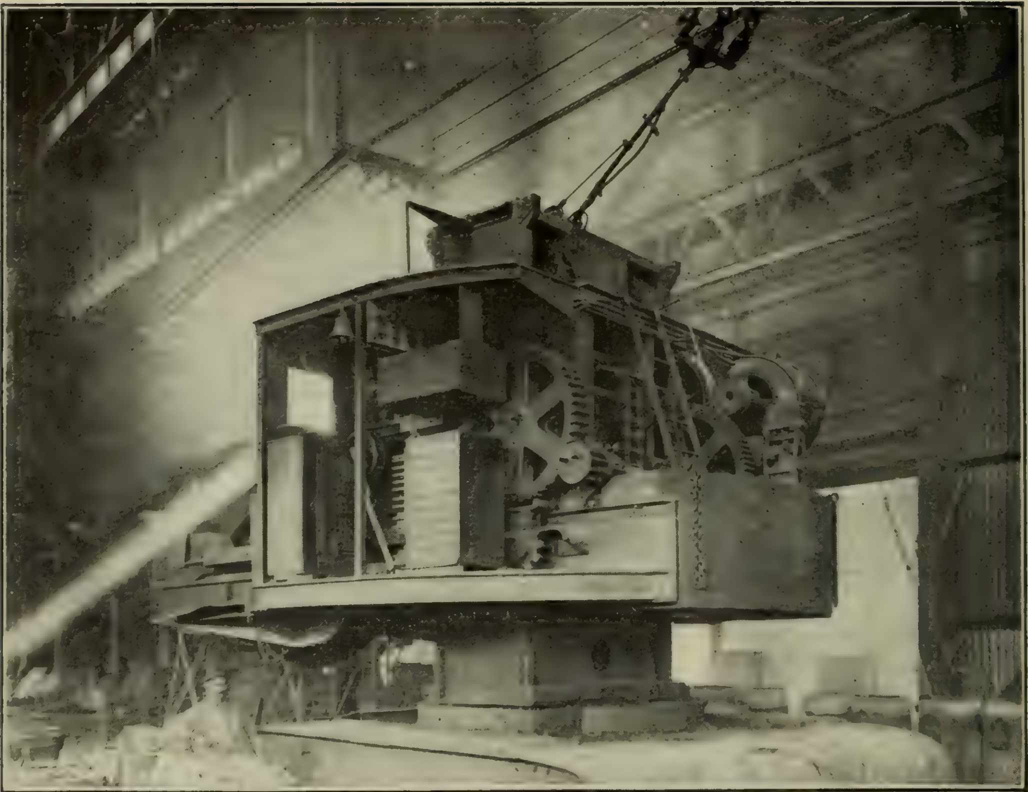


FIG. 4. STARTING SWITCH FOR INDUCTION MOTOR DRIVING WINCH FOR BLAST-FURNACE BELLS.



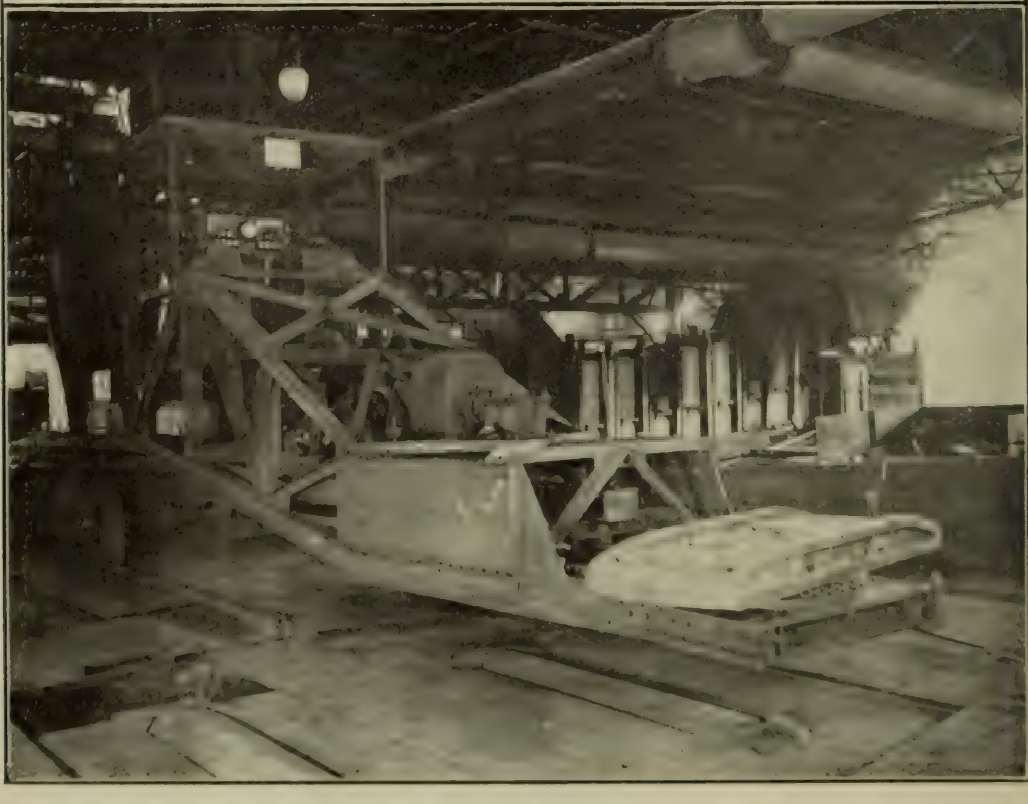


FIG. 7. HEAVY LADLE CRANE, EQUIPPED WITH INDIVIDUAL LIFTING, SLEWING, TIPPING, AND TRAVELING MOTORS.

FIG. 6. AN ELECTRIC-MOTOR DRIVEN CHARGING MACHINE.

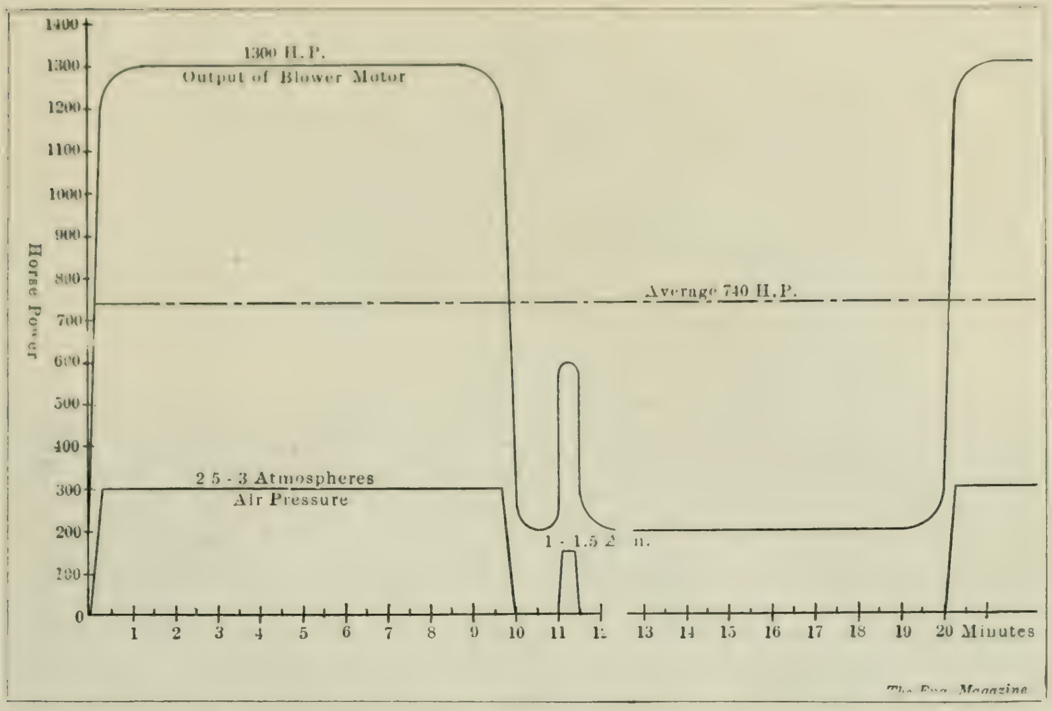


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FIG. 5. LOAD DIAGRAM OF A BESSEMER CONVERTER.

blowers for Bessemer converters, the conditions under which an electric motor works are much more interesting, and are shown by the diagram, Figure 5. During the main blow, it will be noticed that the motor has to deliver about 1,300 horse power, this power falling off prior to the afterblow, and a long period then succeeding during which the converter is being recharged and the motor runs at light load. The average power required throughout the entire cycle is about 70 horse power. Various methods are used to regulate the pressure of the blast, some involving variable-speed motors.

Figures 6, 7, and 8 show application of motors to charging machines, ladle cranes, and ingot cranes. In most cases standard crane-type motors and controlling gear may be adapted for this purpose. Precaution must be taken, however, that the motors are of ample dimensions, and are protected against excessive heating such as would be caused by direct radiation from molten metal.

There is probably no class of service in which electric motors are subject to more severe strains than in driving of live rolls. For reducing the severity of such shocks upon the motors, tight and loose belts have sometimes been employed. Another method is to use a set of reversing gears and friction clutches which allow the motor to run continuously in one direction. With both of these plans, however, the parts are liable to rapid wear and the cost of upkeep is high. By far the most usual practice at present is to gear the motors direct to the rolls, making the motor so substantial in construction, and designing it with such high overload capacities from the commutation standpoint, that it will withstand successfully a reversal of current at full speed, the torque exerted by the reverse current being used for bringing the rolls to rest. This method is much the simplest and most convenient mechanically, as it affords a means of starting and reversing the rolls in a minimum of time, and with a properly designed motor and controller the results obtained by it are excellent. For meeting such heavy duties, special motors (of which Figure 9 shows an example) have been designed. It will be noticed that the shaft at the bearing end of these motors is supported in the most rigid manner; the metal forming the bearing casing is carried as directly as possible to the supporting feet, thus avoiding overhand and the possibility of chattering due to the heavy intermittent strains which come upon the motor pinion. The electrical characteristics of the motors are also such as to enable them to withstand successfully the heavy rush of current which occurs both in starting and at the moment of reversal. Scarcely less arduous is the service which falls upon the controllers, and for such work standard or tram type controllers are

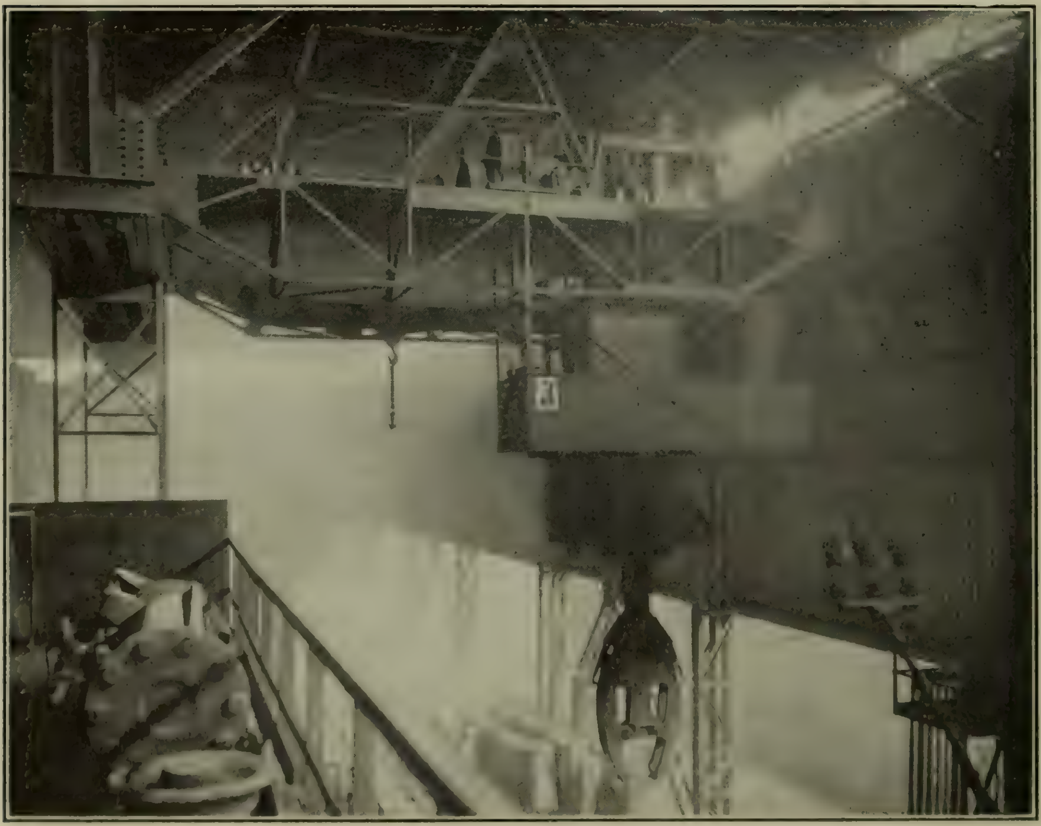


FIG. 8. AN ELECTRIC INGOT CRANE.

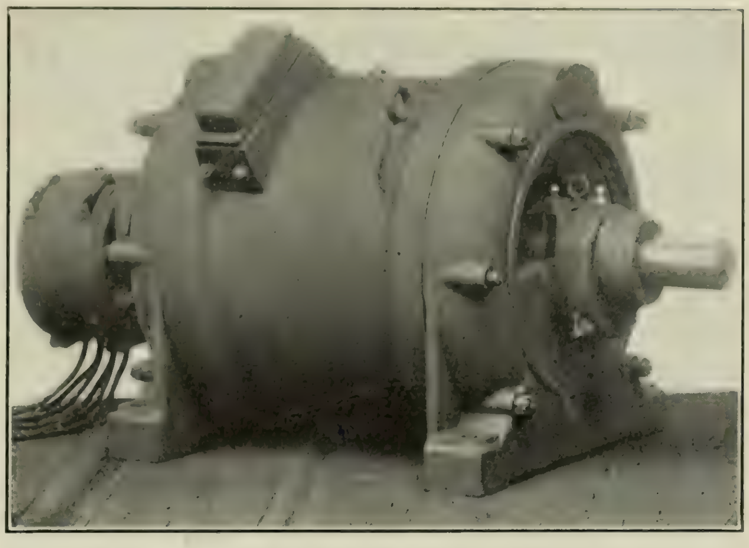


FIG. 9. THREE-PHASE MOTOR FOR DRIVING LIVE ROLLS. NOTE HEAVY END SHIELD SUPPORTING BEARINGS.

entirely unsuitable. In Figure 10 is shown a type of controller which has given excellent results in practice. It is built for either three-phase or continuous-current motors, and consists essentially of a marble panel upon which are mounted heavy contact blocks. The current is controlled by contact fingers with massive carbon tips, the motion of the fingers being obtained by means

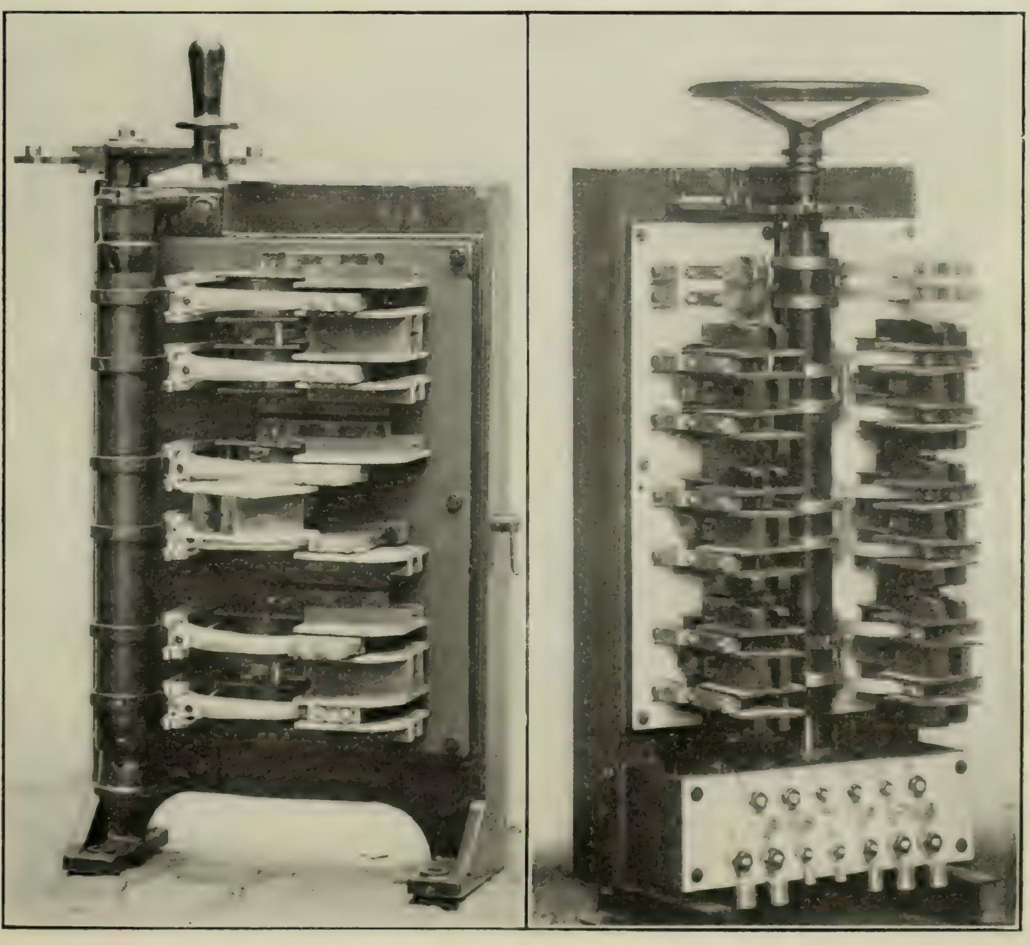
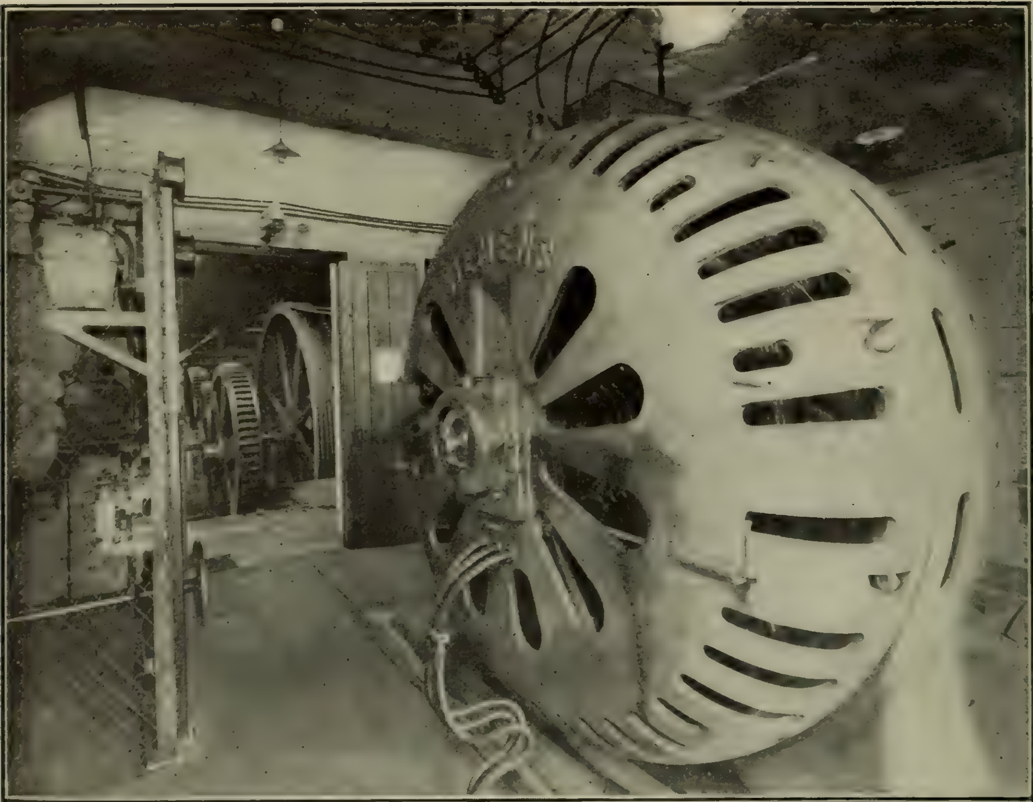


FIG. 10. CONTROLLERS.



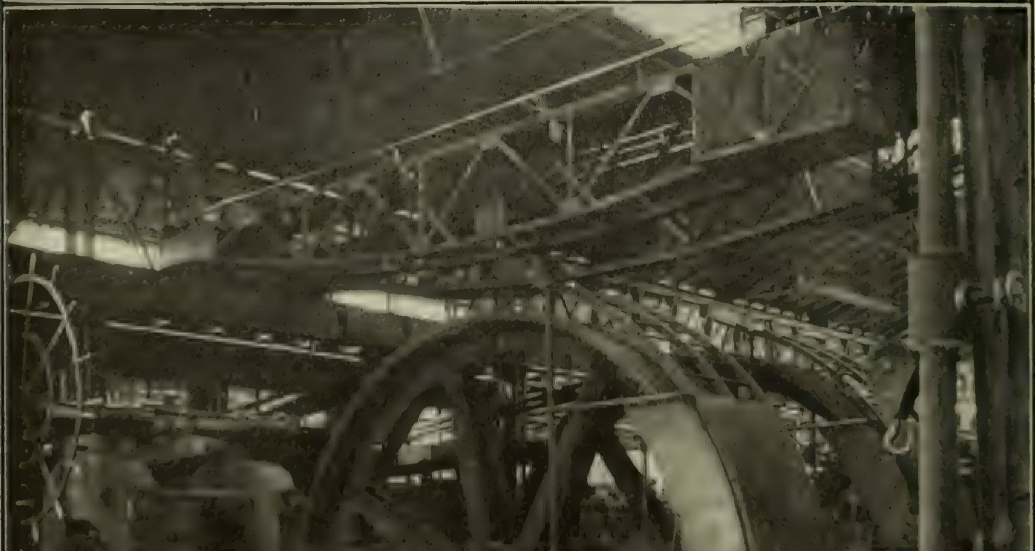


FIG. 12. INDUCTION MOTOR, DRIVING PLATE MILL BY ROPE TRANSMISSION.
FIG. 11. PLATE ROLLS, ROPE-DRIVEN BY ELECTRIC MOTOR.

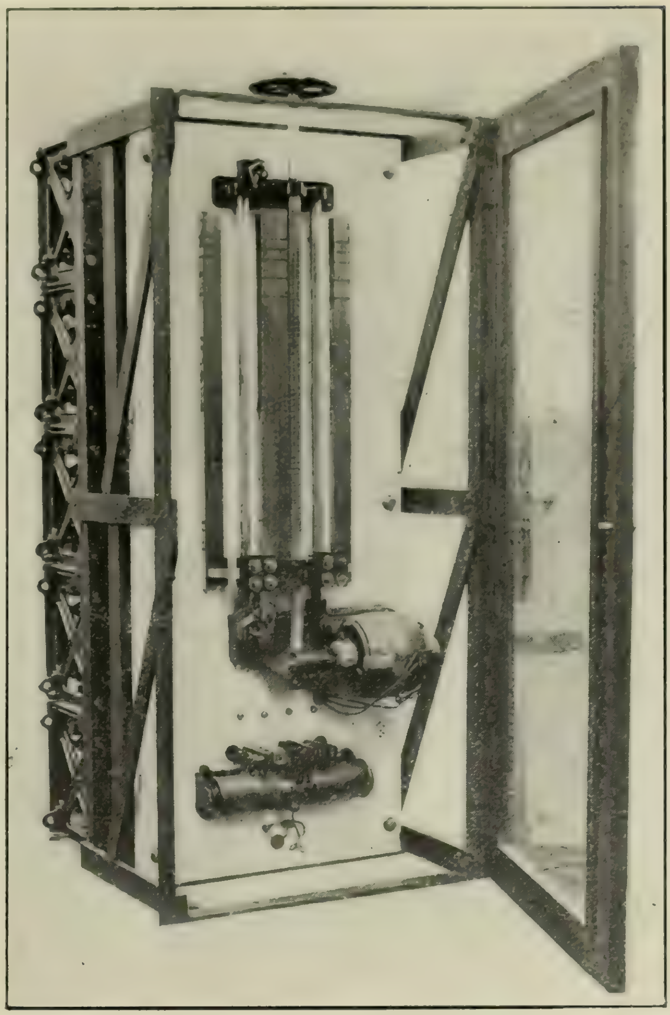


FIG. 13. MOTOR-DRIVEN STARTER.

of a cam shaft with handle or hand wheel. Figures 11 and 12 show typical motors arranged for driving main non-reversing rolls. The massive construction of these motors will be noted, especially the arrangement of the bearings and base-plates, which are designed especially for withstanding the heavy strains that are met with in such drives. Figure 13 shows a motor-driven starter for one of these motors. The contact blocks are mounted upon a marble panel. The sliding contact shoe is operated by a traversing screw worked by a pilot motor, which may be controlled from a distant point. The resistances consist of a cast-iron grids, mounted behind the panel. For large motors of the three-phase type special starters have been designed, of which one of the most interesting is the hot-water type, consisting of a series of contact plates suspended in a tank. By means of a small motor-driven circulating pump, water is made to rise or fall in the tank and submerge the contact plates to any required depth. The water when it comes into contact with the plates boils at the surface and gives off a small quantity of steam which escapes through an outlet pipe. By thus taking advantage of the great latent heat of steam a starter of moderate size and cost can be produced capable of carrying very heavy currents. These starters have been used with great success for main roll motors of large size. An illustration of such a starter is shown in Figure 14. As auxiliary motor-driven machinery, Figure 15 shows an electrically-driven transfer table, with

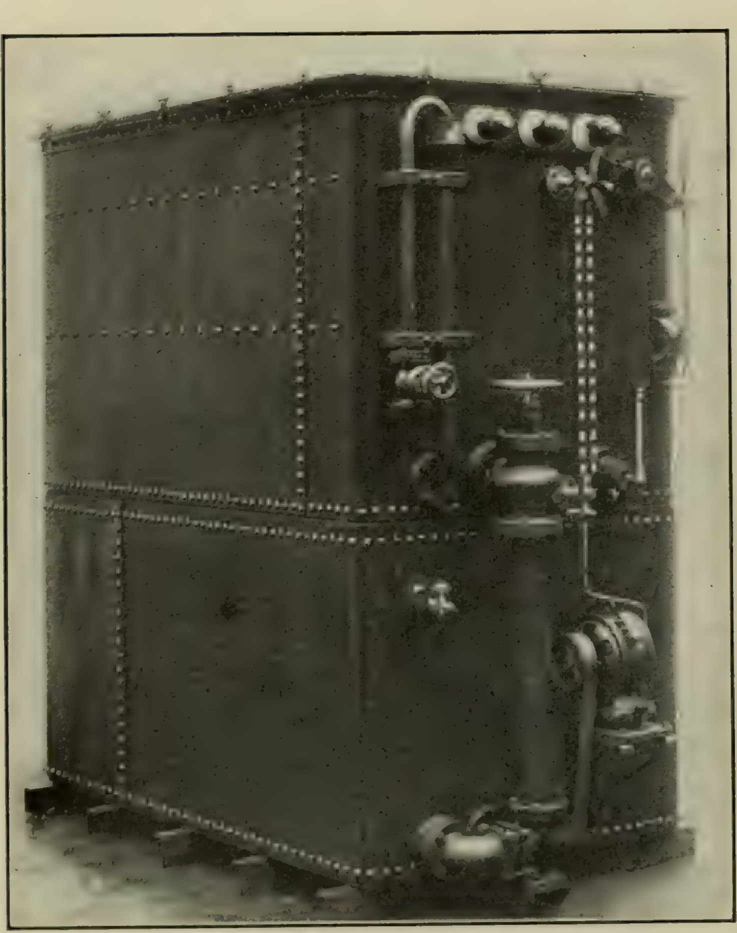
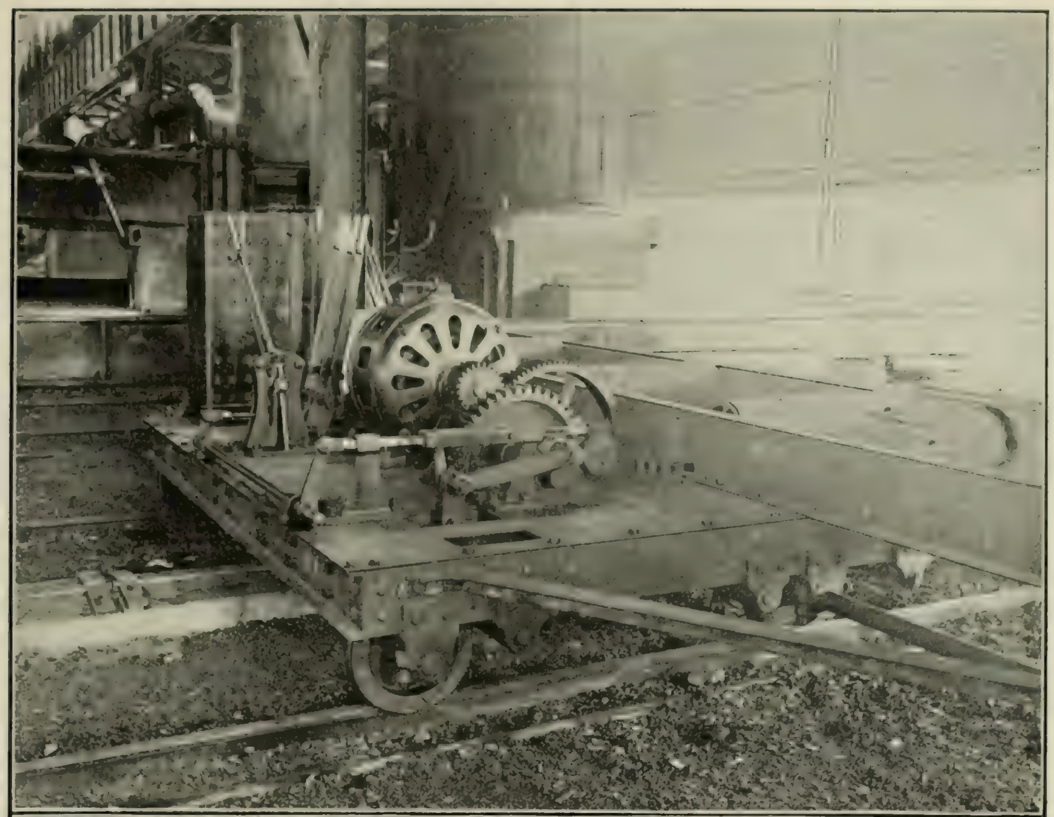


FIG. 14. HOT-WATER STARTER FOR AN 1,800 HORSE-POWER MOTOR.

controller in the background and Figure 16 depicts a rail-bending machine. Figure 17 shows the arrangement of driver's platform in an electrically-driven rolling mill.

The motors used for most purposes about steel works have a very intermittent load, with periods in which the motor is either standing or running light and drawing only a small amount of current. For the smaller motors about the works this variation in power required does not react unfavorably upon the generating station, since there are usually a large number of motors, and their variations tend to neutralise each other and produce an aggregate demand of fairly uniform character. In the case of large motors such as those for driving main rolls, however, the load variation assumes more serious proportions, and it is sometimes desirable to screen the power station from the excessive peak load of these large motors. The most obvious method of doing this is to provide a flywheel on the rolls or motor shaft of sufficient weight for providing, without an excessive reduction in speed, the excess power required at each pass, the flywheel being restored to full speed between the passes. In adopting this plan, care must be taken to design the motor and its control gear so as to permit a drop in speed without a corresponding rise in current demand, and thus to enable the stored energy of the flywheel to be utilised. The practical means of accomplishing this in the case of continuous-current motors is to provide a compound field winding,



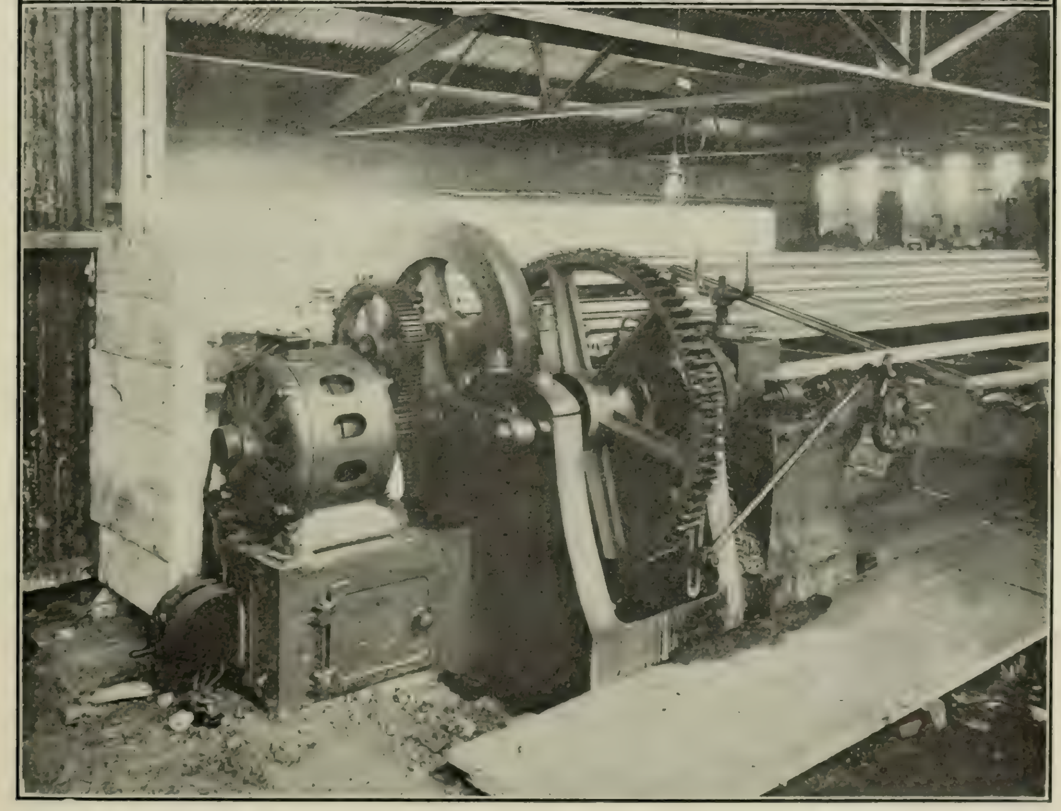


FIG. 15. AN ELECTRICALLY DRIVEN TRANSFER TABLE.
FIG. 16. ELECTRICALLY DRIVEN RAIL-BENDING MACHINE.

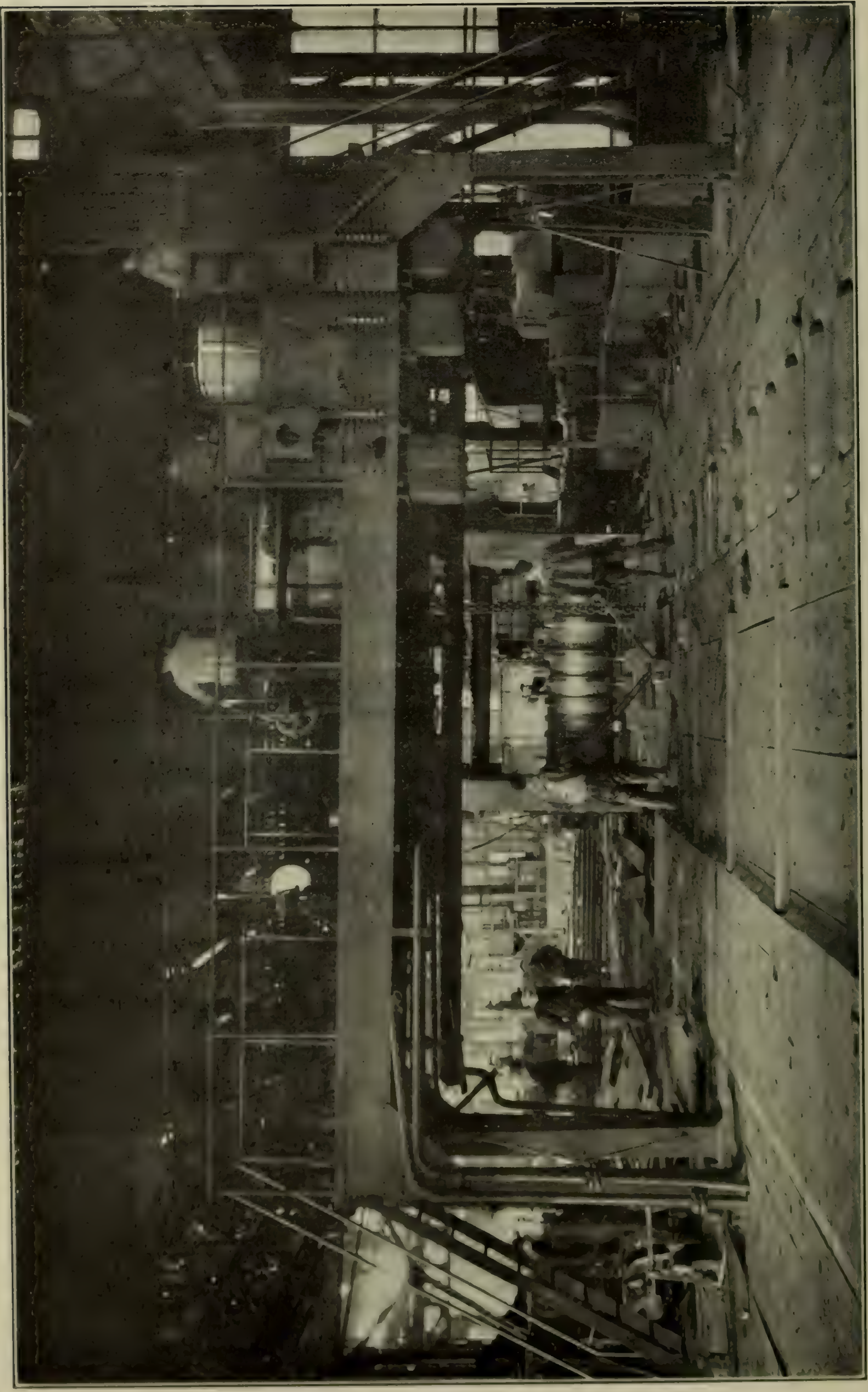


FIG. 17. ARRANGEMENT OF DRIVERS' PLATFORM IN AN ELECTRICALLY DRIVEN ROLLING MILL.

and with induction motors to insert a fixed or a varying resistance in the rotor circuit so as to increase the slip of the motor during the period of heavy load. When it is applicable, this plan is the simplest which can be adopted. There are cases, however, in which the peak loads are either so high or of such long duration that, in order to neutralise them completely by means of a flywheel direct-coupled to the motors or rolls, the weight of the flywheel required would be impracticable. In such cases the excess demand on the generating station may be supplied by a storage battery; but the first cost of a storage battery is high, and also its cost of upkeep; a simpler means of accomplishing the same purpose is attained by coupling the flywheel to the motor-generator; this arrangement enables the flywheel to run at a much higher speed, and therefore, with the same weight of wheel, to store a greater amount of energy. A still better but slightly more costly arrangement is to have a separate generator on the motor-generator set for each main-roll motor. When this is done, a simple means is also afforded for varying the speed of either main-roll motor by changing the field strength of its corresponding generator.

In main reversing rolls, the absolute powers required at the different stages of elongation vary greatly with the temperature of the billets. During the initial stages, when the billet is short, the loads are heavier and their duration shorter. The powers then gradually decrease, and the length of time during which the power is applied increases as the billet elongates, until finally we have the long, low powers of the last passes. In considering the design of the electric drive for such a mill very heavy powers are involved. To be successful, a method must be found which will obviate the necessity of handling directly the enormous currents corresponding to such powers, and the method must also be one which will screen the generating station from the enormous fluctuations in the load demand throughout the process of rolling. A method which accomplishes both of these results is the Ilgner system, and Figure 18 illustrates a type of flywheel converter used with this system for driving main reversing rolls. The mains from the generating station are led to the motor of the flywheel motor-generating set. The generator of this set delivers continuous current to the motor driving the mill, the armatures of the generator and mill motor being connected in series. The field of the mill motor is separately excited, the exciting current for this purpose being obtained from a small auxiliary generator direct-coupled to the motor-generating set, but where the main supply is continuous current, this auxiliary machine can be dispensed with. The field

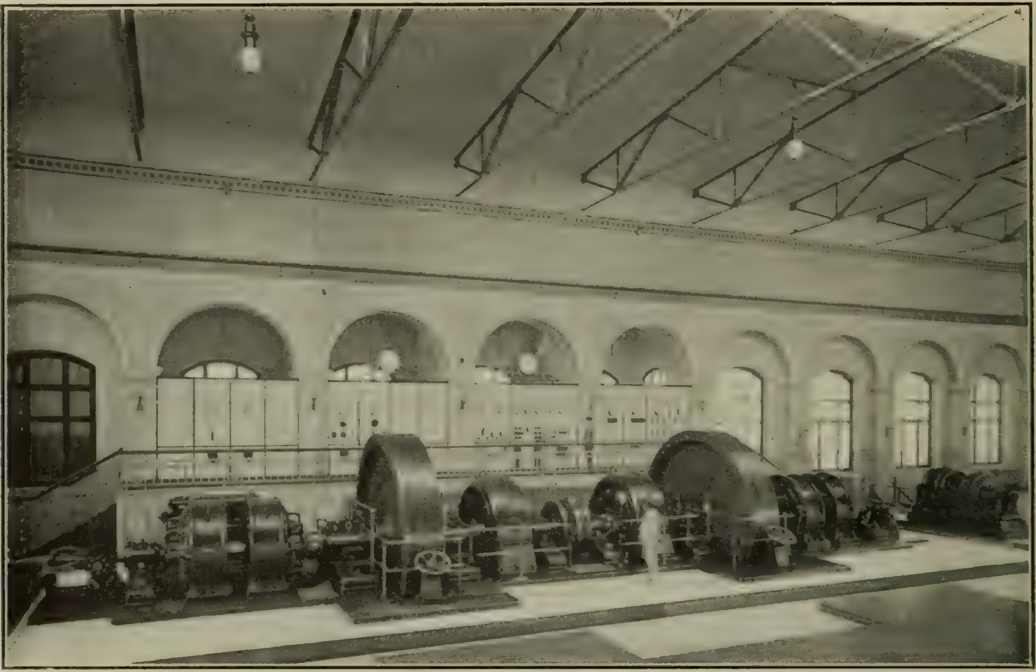


FIG. 18 TYPE OF FLYWHEEL CONVERTER USED WITH ILGNER SYSTEM FOR DRIVING REVERSING ROLLS.

of the generator on the motor-generator set is controlled from 0 to a maximum positive or negative by means of a rheostat placed on the operator's bridge. By moving the rheostat level the field of the generator is thus varied, and the speed and direction of rotation of the mill motor are controlled. The system involves the handling only of a small exciting current required for the generator field. The flywheel is proportioned so that by a reduction of about 15 per cent in speed, it is capable of supplying energy equivalent to the load peaks above the average power line. The speed of the mill motor corresponds to the position of the control lever, and its direction of motion also follows the position of this lever. The system has the advantage that its efficiency remains practically constant at all speeds, and that the power required for accelerating the masses at the beginning of each pass is regained and stored in the flywheel when the masses are brought to rest for the reverse pass. The generating station therefore generates an amount of power corresponding to the average required at a uniform rate, and thus works under very efficient conditions.

GENERAL PRINCIPLES IN THE CONSTRUCTION OF MODERN GAS PRODUCERS.

By R. E. Mathot.

The use of fuel in internal-combustion engines has not only the interest of its vast commercial and technical importance, but in addition that always attaching to a new development which has grown vigorously along many branches and is but now arriving at maturity and fixity of form. Standard principles, here as elsewhere, are the fruit of the collated experience of many experimenters in different parts of the subject. Mr. Mathot's work, as specialist in this field of mechanical engineering and industrial application, has been to gather these standards from all sources, on both sides of the Atlantic. In a preceding paper he laid down the leading principles controlling the design and construction of the gas engine, as he accepts and adopts them in his practice. He completes the review in the following pages by treating in the same way the settled elements of producer design and installation.—THE EDITORS.

ANY perfection attained in the construction of gas engines, and even the utmost ingenuity applied to methods for assuring their regular operation, would have no practical interest if it were not possible to supply them cheaply with power gas. This consideration eliminates at the outset city gas and petrol spirit for any industrial installations exceeding 15 to 20 horse power and operating continuously.

The solution of the problem has been found for the metallurgical industry by the utilization of blast-furnace gas, and elsewhere by the introduction of gas producers. These are divided into two general categories—pressure, (Figure 1), and suction, (Figure 2). Of these the former are the more complicated. They require the installation of a holder to contain a reserve supply of gas and of a steam boiler or a fan. They involve a certain measure of danger through the possible escape of carbonic oxide and the explosions which may occur. On the other hand, they are particularly well adapted for the supply of a number of separate motor units installed at a greater or less distance from one another and from the generating apparatus.

Producers, of whatever system, include three principal groups of apparatus: the generator, the vaporizer, and the purifier. We shall consider, particularly, producers operating with anthracite, semi-anthracite, or coke, setting aside for the present bituminous-coal producers, which necessitate special appliances and which, further, have

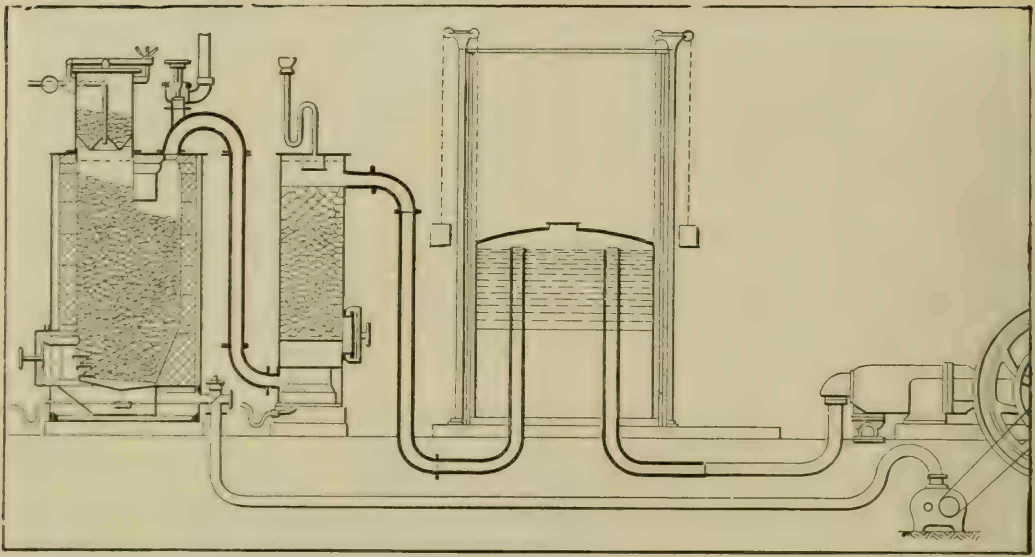


FIG. I. DIAGRAM OF ARRANGEMENT OF PRESSURE PRODUCER.

not in general up to the present time given substantial practical results.

THE GENERATOR.

The generator consists of a vertical shell, cast or built of steel or iron plates, in which is placed a lining of refractory brick generally separated from the shell by a bed of sand, asbestos or other non-conductor of heat. The fuel is charged into the top of the retort which is closed by a double valve to prevent the entrance of air into the apparatus during charging. This double seal is indispensable and the outer cap should be attached to the apparatus by a hinged joint. The arrangement with the outer cover entirely removable is not to be recommended. Figure 3.

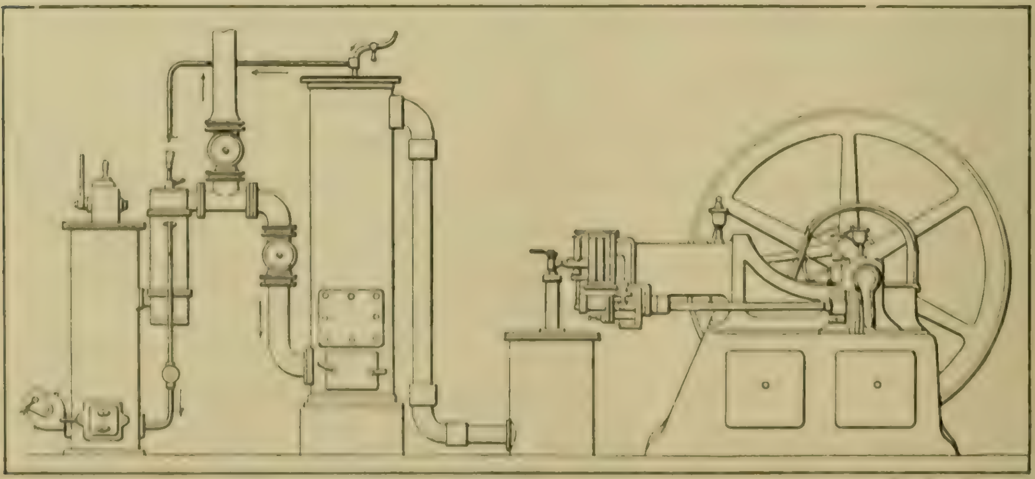


FIG. 2. DIAGRAM OF ARRANGEMENT OF SUCTION PRODUCER.

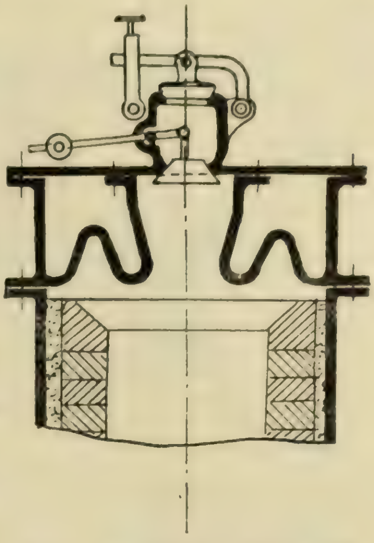


FIG. 3. DOUBLE SEAL FOR GENERATOR TOP.

At the base of the internal brick lining is installed a grate through which the ashes fall. In most producers this grate is horizontal and substantially of the same diameter as the producer lining. The result with fuel containing a large proportion of cinders (10 to 15 per cent) is that the grate is very soon choked, unless the ash-pit doors are frequently opened for the purpose of cleaning. This operation, by frequent admissions of air, necessarily disturbs the production of the gas. This disadvantage may be avoided by using a grate in the form of a basket, which affords a large area for air passages. Figure 4. Into the ash pit is admitted the air mixed with steam, which is to produce with the incandescent coal the reactions yielding fuel gas. The weight of steam introduced varies with varying types of apparatus. In general, it is close to the weight of the combustible consumed. Further, it may be the greater, the hotter the working of the furnace. The higher the temperature above the grate, the richer is the gas produced. The most rational and most efficient means of securing this high temperature is to superheat the mixture of air and steam before their introduction into the ash pit, but certain precautions are necessary in securing this result. The grate should be so set and constructed as not to be subject to rapid deterioration. The heat employed for the superheating should be obtained exclusively from gas which has passed out of the producers. Taking it from the incandescent zone or even from the ashes must be carefully avoided, under penalty of receiving no benefit whatever from the superheat so far as concerns the combustion of the fuel.

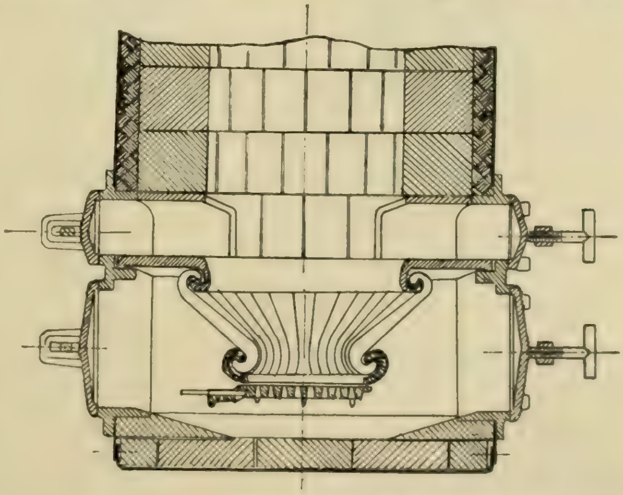


FIG. 4. BASKET GRATE FOR PRODUCER.

The use of superheat necessarily excludes any arrangement which involves the maintenance of a reserve of water in the ash pit, whether this be done with a view of protecting the grate from over heating or whether for cooling the ashes to prevent the formation of clinkers, which happens particularly with coal containing considerable iron.

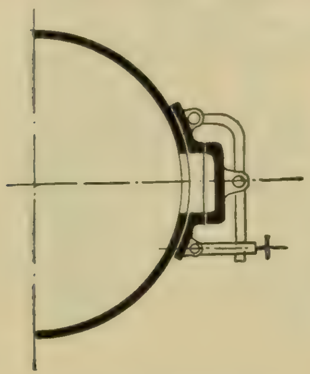


FIG. 5. METHOD OF CLOSING FIRE DOORS.

The doors of the fire-pot and of the ash pit should be hermetically closed, metal to metal. They are commonly fastened by hinged bolts furnished with wing nuts (Figure 5). Some generators have been constructed with open ash pits (Figure 6). This arrangement presents some advantages in so far as it permits the stirring of the fire or the removal of ashes at any time without disturbing the operation of the apparatus, but at the same time it prevents the preheating of the air.

The gas is usually drawn off from the periphery of the apparatus in the annular part surrounding the charging hopper. This design possesses the advantage of favoring the discharge of the gas from the whole mass of the fuel over a large surface, thus reducing the speed of the circulation and preventing the entrainment of too much dust. On the other hand, it has the disadvantage of creating a flow of air along the walls of the generator, because that is the passage of least resistance, so that a certain quantity of air may pass out with the gas without sufficient contact with the incandescent fuel to complete the proper reaction. I therefore recommend the use of apparatus with a central gas discharge, giving this exit pipe dimensions great enough to prevent any abnormal entrainment of dust. In connection with this, it is desirable to furnish the gas exit pipe with a dust chamber which can be easily cleaned (Figure 8). It is well to provide, at several points on the height of the producer shaft, peep holes through which the position of the incandescent zone may be observed. Around the charging hopper, also, openings should be

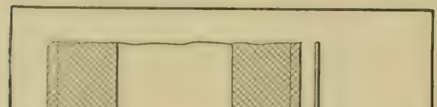


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FIG. 6. GENERATOR WITH OPEN ASH PIT.

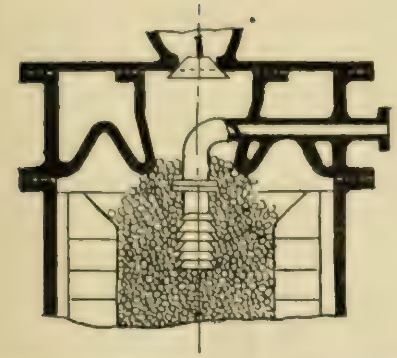

FIG. 7. CENTRAL GAS DISCHARGE.

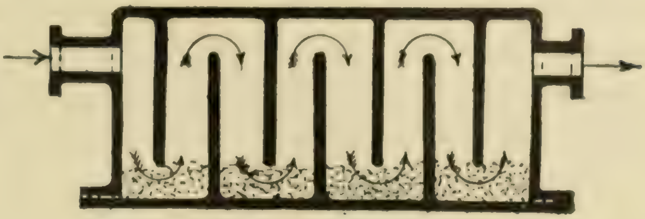

FIG. 8. DUST CHAMBER.

provided through which, if necessary, a poker may be introduced to quicken the descent of the fuel. Figure 9.

To summarize, the following are the principal conditions which should be secured in the design and construction of the producer generator. That is to say:

A double-doored charging hopper designed to give good distribution of the fuel.

Internal lines assuring easy descent of the fuel.

Heating of the mixture of steam and air by which combustion is maintained.

The use of grates of large area, cleaned so far as possible from the outside without the need of opening the ash pit.

Absolute tightness of all the joints of the apparatus, especially of those which are in contact with the fuel gas after its formation.

On the pipe through which the gas passes from the producer is placed a connection communicating with a chimney open to the air. This must be closed by a valve which is absolutely tight. It serves for blowing off the gas and smoke during the firing up of the generator, and it is used also to maintain a natural draft sufficient to support a slow rate of combustion during periods of stoppage. (Figures 10 and 11).

The generator should be so made that it can operate continuously for six or seven days without being extinguished, and it should be capable of maintaining a banked fire for ten or

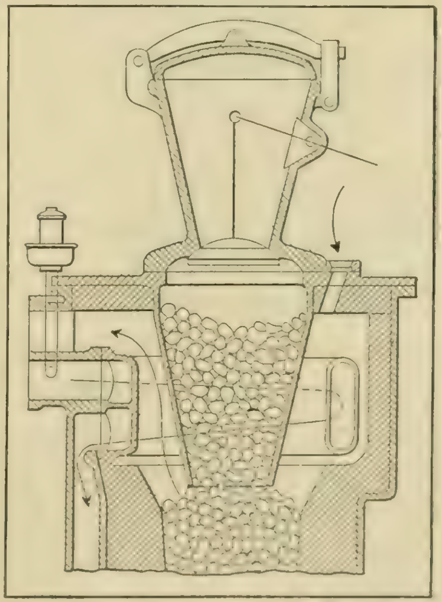

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FIG. 9. POKER OPENING NEAR CHARGING HOPPER.

twelve consecutive hours of stoppage, so that for putting it into service again the only necessity is the reviving of the fire. The necessary time for reviving the fire under these conditions with a suction producer should not exceed ten or fifteen minutes, and the time requisite for obtaining a gas suitable for use, starting with the generator cold and firing it anew, should be about one-half hour.

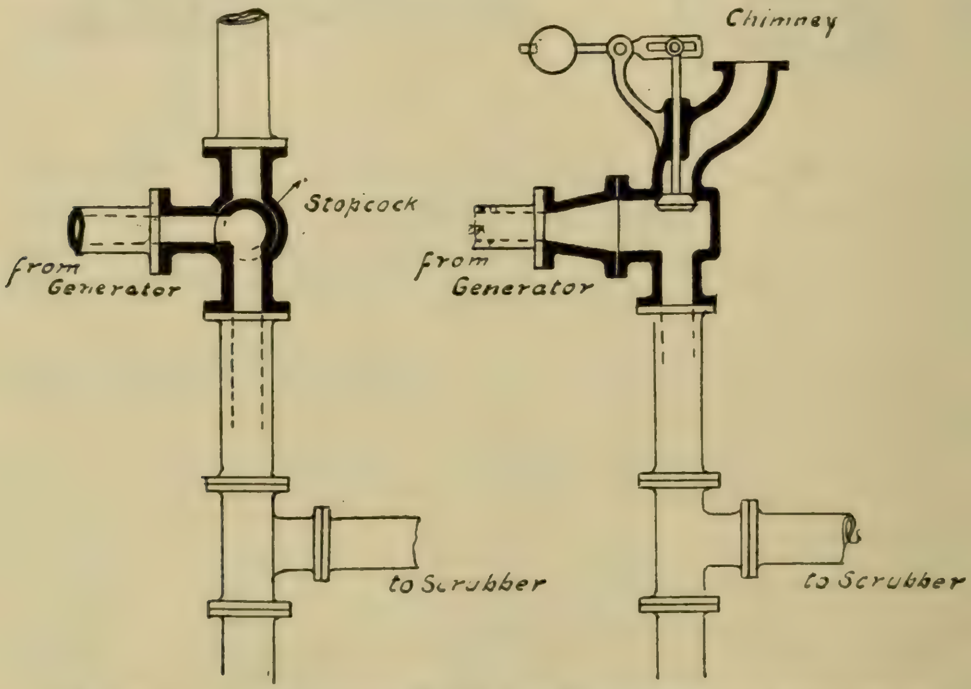

FIG. 10, 11. CONNECTIONS OF GAS DISCHARGE PIPE WITH CHIMNEY.

For reasons of economy the refractory lining should be made of such form that it can be built and thereafter maintained with fire-brick of a single standard shape.

THE VAPORIZER.

A large numer of types of vaporizer have been brought out. We may divide them into two categories—those which are placed outside the generator and those which form a part of it.

Independent Vaporizers.—These consist of a sort of boiler at atmospheric pressure heated by means of the gas passing from the generator. They are made in various forms. Many of them are characterized by a general defect of installation in that their cleaning and the removal of scale is very difficult. From this point of view, especially, those fitted with tubes of the Field type should be absolutely proscribed if the water with which they are to be supplied contains any notable proportion of calcareous sediment. (Figures 12, 13).

Internal Vaporizers.—All generators with interior vaporizers are based upon the Otto-Deutz, Wiedenfeld and similar types. They are composed of an annular vaporizing chamber disposed about the upper part of the generator, under which the hot gas circulates (Figure 3). This vaporizer is generally cast. It should be so designed as to support without rupture the effects of expansion and should be provided with a removable cover or with cleaning doors to permit the removal of incrustations. These latter, especially in large apparatus, might cause rupture.

Although they do not constitute a boiler, properly speaking, the elements of superheater apparatus may be included among the classes of available vaporizers. These are, in effect, flash boilers, so arranged that the feed water falls drop by drop upon a surface superheated by the passage of the gas. The evaporation of the water proceeds simultaneously with its inflow.

Some vaporizers are placed in the ashpit of the generator (Figure 6). I am of the opinion that this position is inadvisable, because the evaporation is produced by means of the heat of the ashes, which are thus rapidly cooled and in consequence cannot by radiation contribute effectively to the maintenance of a high temperature in the zone of incandescence.

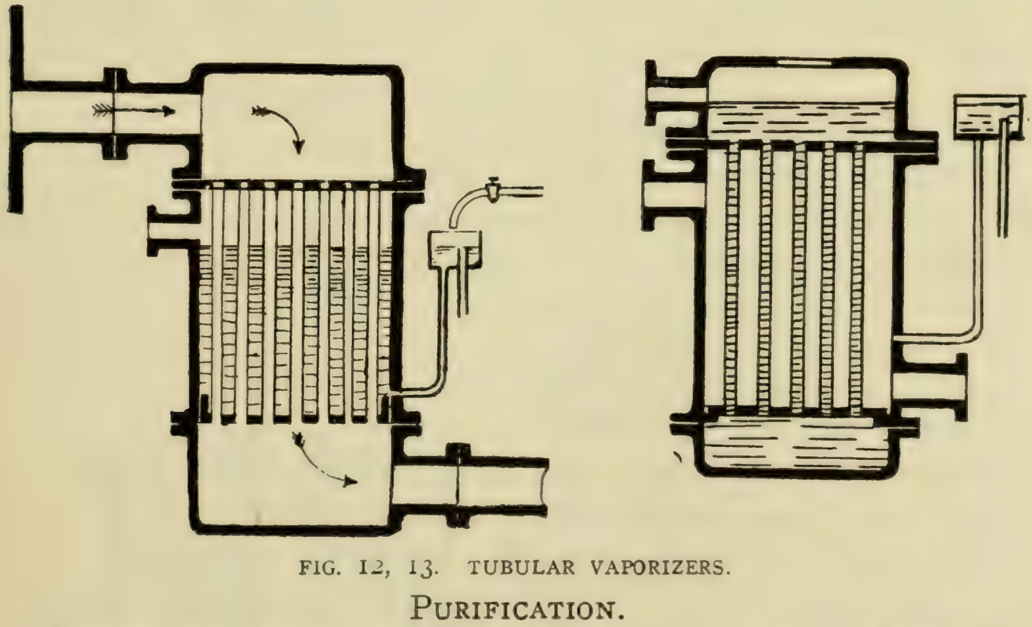

FIG. 12, 13. TUBULAR VAPORIZERS.

PURIFICATION.

In pressure generators effort is generally made to purify the gas as completely as possible. This, moreover, is relatively easy to do, because the gas is delivered under pressure sufficient to force it through several pieces of purifying apparatus containing chemicals or absorptive substances designed to remove the impurities from the gas. So far as suction producers are concerned, purification, prop-

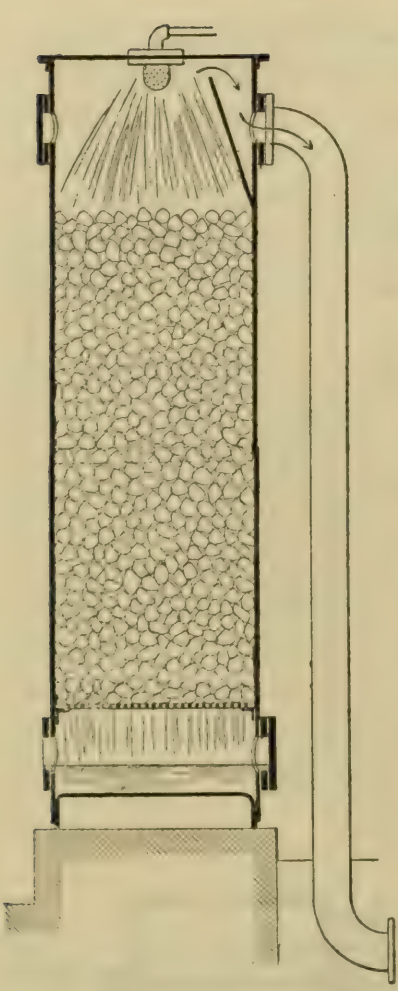

FIG. 16. SCRUBBER.

erly speaking, is usually discarded, and we are content to employ scrubbers (Figure 16) in which a simple washing of the gas is accomplished by means of jets of water falling through a mass of coke conveniently arranged in a closed cylinder. Occasionally, in large installations, two scrubbers are placed in series, or a single scrubber is followed by a purifier containing wood fibre or some other material serving to effect a physical purification (Figure 17). The discharge of the washing water from the scrubber is effected by means of an overflow siphon, or in other cases by a simple vertical tube dipping into the tank which serves to form an hydraulic seal (Figure 18).

In filling the scrubber the largest pieces of coke should be placed at the bottom and the finer fragments toward the upper part. Whatever may be the form of the scrubbers and the purifiers, they should be provided with doors permitting the cleaning of the apparatus and the easy removal and replacement of the materials with which they are filled. Many scrubbers are equipped with a single opening only at the base to allow the removal of the coke. This is a very bad arrangement, because the filling of the apparatus requires the unbolting and removal of the whole upper cover to which piping is usually attached. This annoyance can be entirely avoided by furnishing the apparatus with a charging door which can be quickly and easily opened (Figure 19).

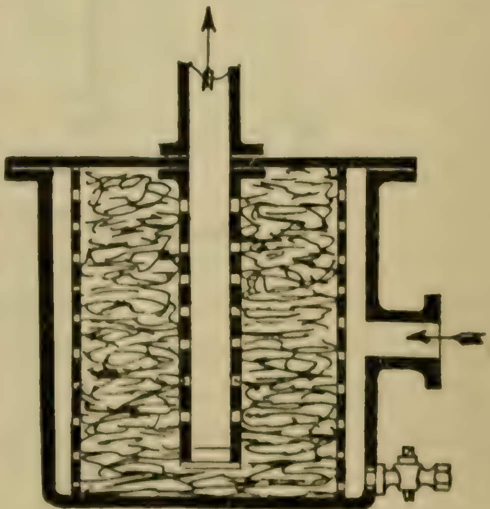

FIG. 17. PURIFIER.

PIPING.

Suction producers for power gas should be provided with a gas reservoir placed in the piping system between the scrubber and the motor, and of dimensions sufficient to minimize the effects of variation in the suction caused by the motor. This gas pot should be provided with a hand-hole for cleaning and with a discharge cock for emptying out the water which may accumulate in it.

Generally speaking, all the piping connecting the various parts of a producer system should be connected at the joints by tees or crosses, or preferably, by capped elbows, the object being to make the examination and cleaning of the pipes easy and convenient (Figures 20 and 21). All joints must be perfectly tight.

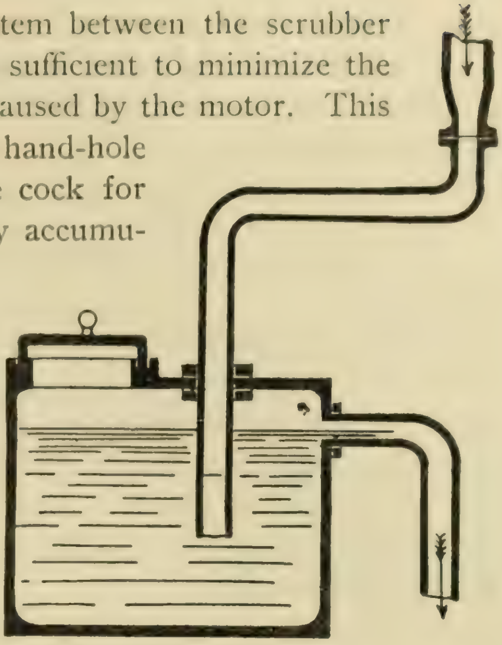

FIG. 18. HYDRAULIC SEAL.

It will prove useful to place cocks at several points on the piping system with a view of installing manometers or pipes for drawing off the gas in order to make check observations on the working of the apparatus.

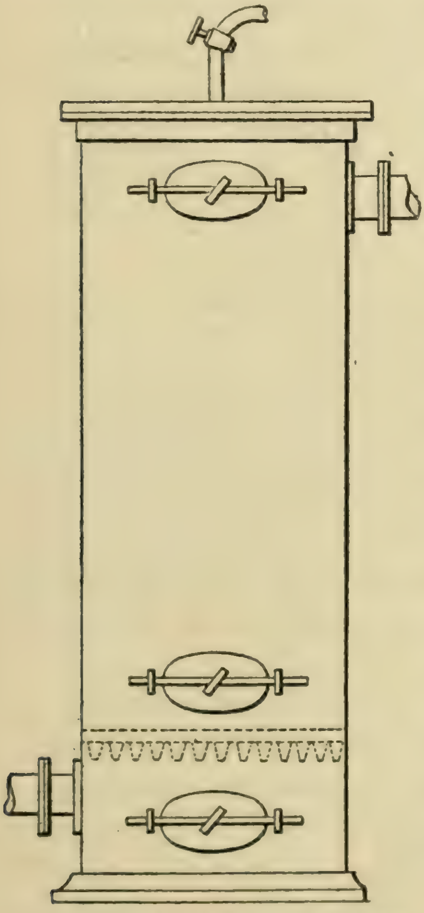

FIG. 19. SCRUBBER WITH CHARGING DOORS.

The washing water from the scrubbers carries sulphurous acid, ammonia, and sulphuretted hydrogen. It therefore gives off a disagreeable odor which necessitates precautions for its removal, especially in case of installations in settled localities.

The purification of the gas, whether obtained by scrubbers or by purifiers of whatever system, should be so complete that the admission valves of the motor to which the gas is supplied should not need cleaning oftener than twice a week. This result is very easily attained when the fuel employed is anthracite or lean coal (semi-anthracite) containing 6½ per cent of volatile combustible and 8 per cent of ash. It is, however, necessary that the scrubber shall be made large enough, that the coke shall be properly placed in it, and that the quantity of water employed for washing shall be ample to cool the gas completely.

ACCESSORIES.

The installation of pressure generators involves a number of accessories.

Blowers.—The blast may be secured by means of the steam jet, in which case it is necessary to provide a boiler. Steam should be furnished to the blower at a pressure of at least five atmospheres and the duty should be regulated by automatic control in accordance with the height of the gasometer. The draft for the producer may also be obtained by means of a fan driven either by the motor itself or by independent power.

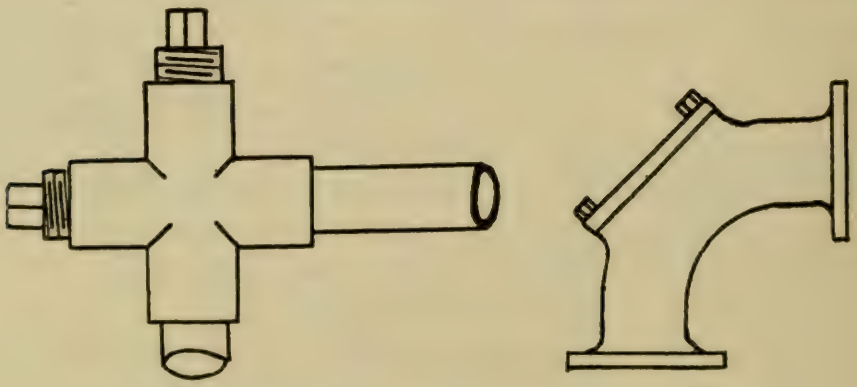

FIG. 20, 21. FORMS OF CONNECTIONS FOR GAS PIPING.

Gasometer.—This is constructed in the usual form adopted by gas works. The tank should be of sufficient dimensions to hold about 100 litres (say 4 cubic feet) of gas per effective horse power per hour of the gas engine supplied. A special device should be placed in the interior of the tank to prevent water from entering the suction pipe of the motor through any stoppage in the production of gas.

Most of the accidents which have happened in pressure-generator installations have been caused by the gasometer, and have arisen from the fact that either by wrong manipulation or by an unforeseen admission of air, the gas holder has been filled with an explosive mixture of air and gas. It is consequently indispensable to equip every stop cock about the gas holder with a wire-gauze diaphragm designed to prevent any possible back draft of flame.

THE INSTALLATION OF PRODUCER-GAS ENGINES.

In a preceding article (THE ENGINEERING MAGAZINE, June, 1907), we examined from the point of view of construction the most important features which enter into the design of gas engines operating with power gas. It remains now to look at certain problems which arise in their installation properly speaking. These are especially:

The construction of foundations.

Water circulation for the several parts of the apparatus.

Piping for the gas and the exhaust.

Starting appliances.

Foundations.—Motor foundations must be designed according to the character of the soil upon which they rest. They must embody a sufficient mass to resist the violent strains which are put upon the anchorage bolts when the motors are running. They should be constructed of materials of good quality, laid in mortar containing two parts of good sand and one part of cement. In order to avoid the transmission of vibrations, the foundations must be kept entirely distinct from any other masonry in the neighborhood, and if necessary they should be set in an isolated pit.

Engine builders generally content themselves with supplying to their patrons an ordinary foundation plan without troubling themselves to look into the special requirements of each installation. This mode of procedure may result in very serious consequences for the buyer. The latter, therefore, as a measure of prudence, should employ an engineer competent to determine what special conditions, if any, must be recognized and provided for.

Water Circulation.—Here, also, the necessary arrangements must be studied out for each particular case. A gas-engine installation supplied with producer gas normally consumes, per horse-power hour under full load, 25 litres for the cooling of the motor (if the cooling water is wasted) 15 litres for washing the gas in the scrubber, and one-half litre for the vaporizer supplying the generator; this makes a total of, say, 40 litres (about 11 gallons). Instead of wasting the cooling water from the motor, we may use a thermo-siphon or cooling tower. In this case, the consumption of water for the motor becomes, we might say, nil. It is necessary only to make up for losses by evaporation and these would scarcely exceed a half pint per horse-power hour. The washing water from the scrubber must be considered as waste in almost every case. Nevertheless, if it is imperative to economize water to the utmost possible, special devices may be used to reemploy this wash water almost indefinitely. The water for the vaporizer is necessarily lost, as it is converted into steam, and by its passage through the incandescent fuel is later decomposed and recombined into hydrogen and carbonic oxide.

Waste of the cooling water from the motor is not advisable, except for small motors and in situations where there is an available water supply carrying but a very small percentage of lime salts in solution. These, if present, are deposited rapidly in the motor casing, interfering with the circulation of the water and preventing the normal transmission of heat from the metal walls thus covered with deposits. This may even result in accident and in the breakage of parts. Cooling by means of reservoirs with thermo-siphon is not to be recommended for motors exceeding 50 horse power; and when, on account of local conditions, it is necessary to place the reservoir at a considerable distance from the gas engine, a circulating pump may profitably be introduced into the circuit. In this case a by-pass with stop cock should be provided in the piping system (Figure 26). The capacity of each reservoir is generally from 1,500 to 2,000 litres. Their number should be determined by the total quantity of water to be handled, which should correspond to 200-250 litres per horse-power hour in the case of motors governed by hit or miss, and 250-300 litres for motors governed by variable admission. The most rational solution is, therefore, to use cooling towers.

Two arrangements may be made, depending upon whether it is desired that the circulation shall be by open flow, thus permitting constant control of the water temperature, or whether it is decided to adopt an entirely closed circuit. In the former case, the water flows by pressure due to difference of level from the cooling-tower platform to the motor, circulates in the cylinder jacket, and discharges freely into a funnel from which it passes by a pipe into a cistern to be again withdrawn by a pump forcing it to the top of the

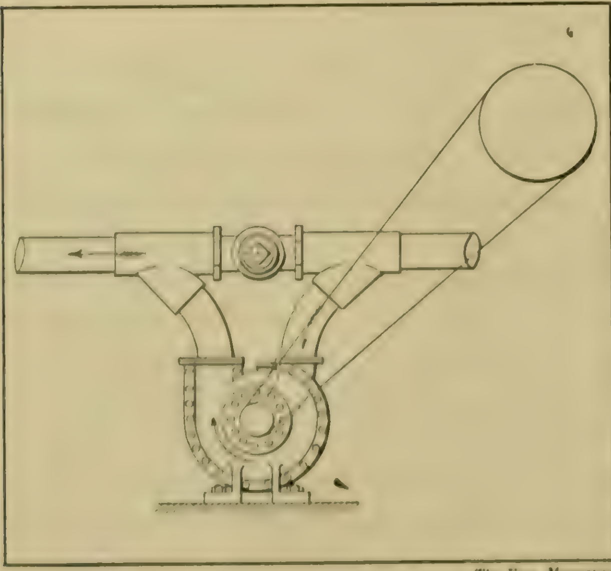
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FIG. 26. CIRCULATING PUMP WITH BY-PASS.

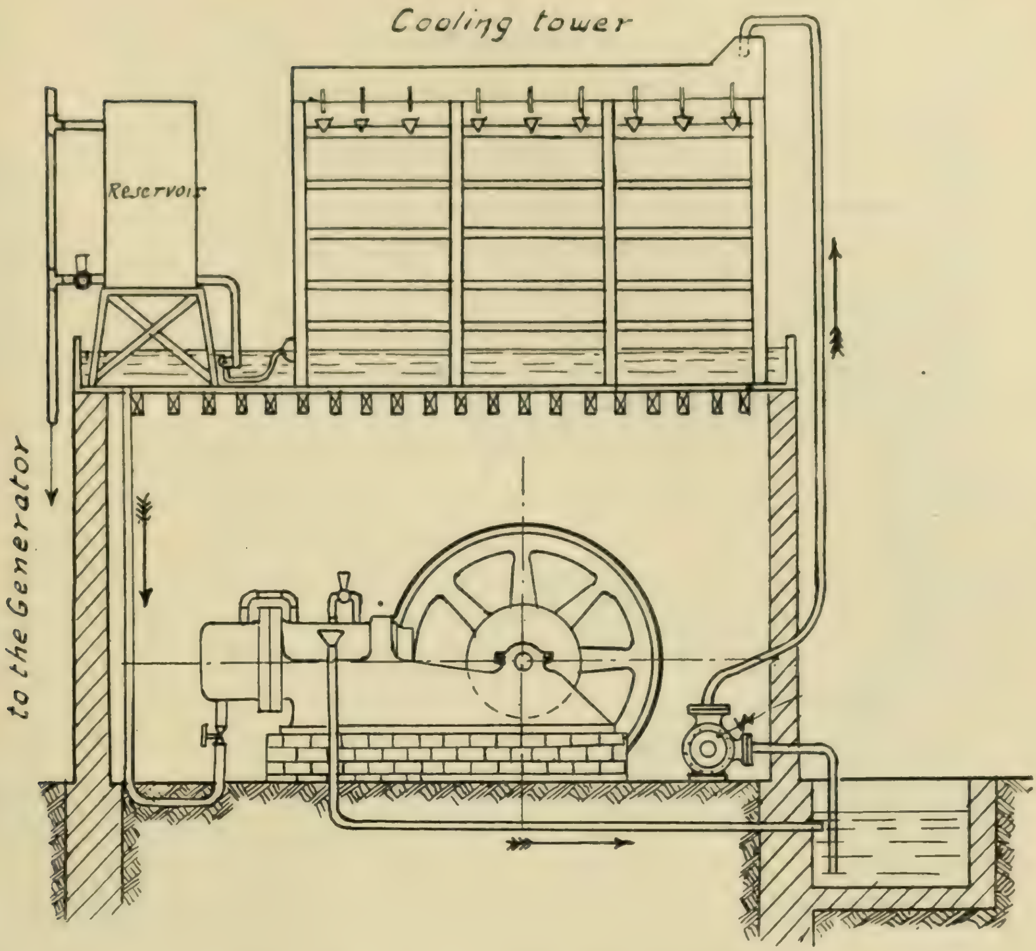

FIG. 27. COOLING-TOWER INSTALLATION WITH OPEN-CIRCUIT CIRCULATING SYSTEM.

cooling tower (Figure 27). It should be noted that this arrangement has the disadvantage of requiring that the pump shall handle hot water (100 to 120 degrees F.) and that this pump must, therefore, be so installed that the temperature of the water does not interfere with the suction. As a precautionary measure, a tank should be provided large enough to contain a reserve water supply sufficient for supplying the motor during one or two hours of operation with the cooling water wasted, in case there should be any interruption to the working of the pump. This end may be secured by having two outlets from the tank to the water-supply pipe, the lower one furnished with a stop cock, which is opened only in case the motor-cooling water is to be wasted.

In a closed-circuit installation the pump receives on the suction side the cold water flowing from the tank on the platform above and forces it back through the motor jackets to the top of the cooling tower (Figure 28). With this arrangement it is not possible to ob-

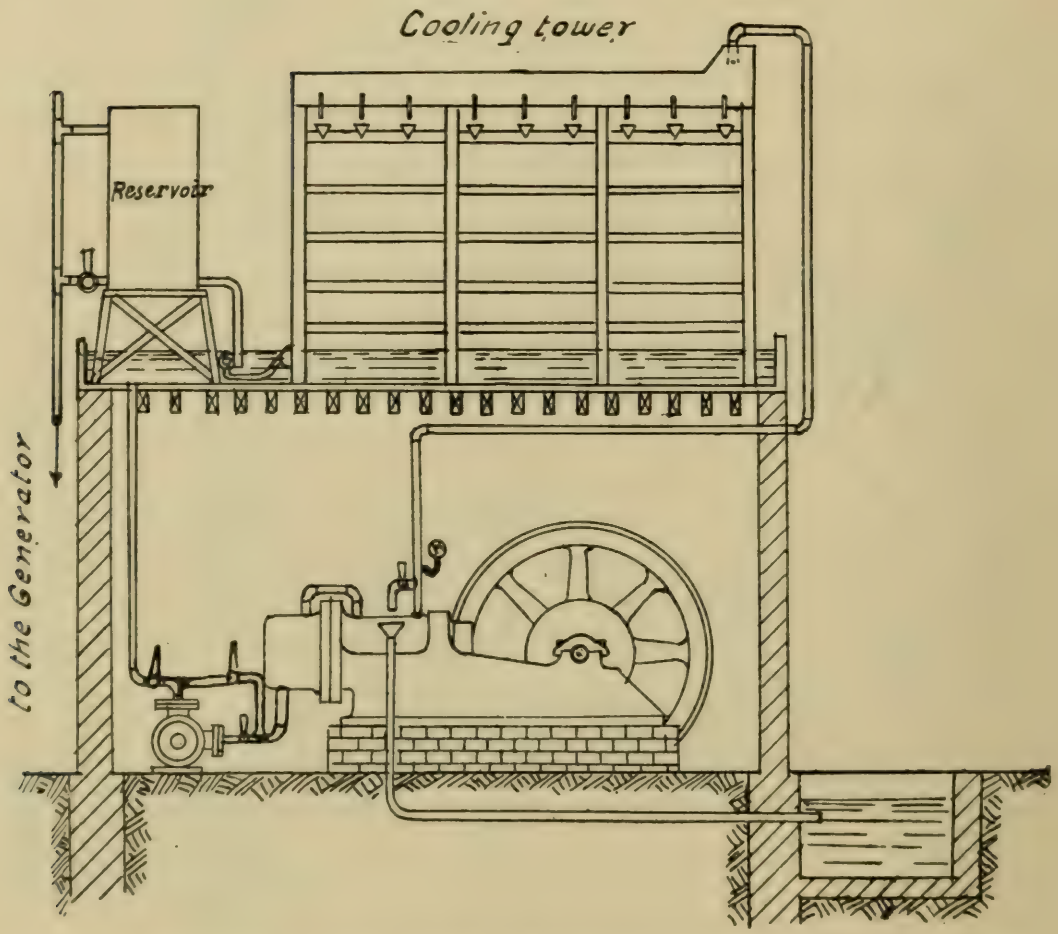

FIG. 28. COOLING-TOWER INSTALLATION WITH CLOSED-CIRCUIT WATER CIRCULATION.

serve whether the circulation is proceeding normally by watching the discharge jet. Nevertheless, a gauge may be installed on the return pipe, just at the exit from the motor, and its oscillations will indicate how the circulation is proceeding. With this form of apparatus, also, provision must be made for a reserve supply of cooling water to be used and run to waste in case of a pump breakdown and consequent repairs. The piping system must, therefore, be provided with three stop cocks to by-pass the circulation and permit cutting out the pump.

As cooling by means of cooling towers has for its purpose on one hand economy of water, and on the other hand the prevention of incrustation or scale in the motor jackets, we must evidently avoid the use of a single reservoir for feeding both the motor and the scrubber. Operation under this plan would manifestly involve a constant admixture of fresh water with that which had been once used for cooling purposes, and in consequence the lime deposits would be much greater than if the same quantity of water were continuously employed over and over solely for motor cooling.

The scrubber is best supplied by means of a regulating tank of one or two cubic-metres capacity, placed, whenever possible, at a height of five or six metres above the top of the scrubber, the purpose of this being to assure the delivery of the water to the scrubber under sufficient pressure to scatter it in a fine rain from the sprinkler. If the pressure is insufficient it will flow in mass in a single jet or stream from a central point and the washing of the gas in the apparatus will be ill accomplished. This regulating tank should be placed at a higher level than the platform of the cooling tower for the motor, so that by the use of a ball cock the small quantity of water necessary to compensate for evaporation may from time to time be supplied to the cooling tower.

Water which has been used for washing the gas in the scrubber contains in solution ammoniacal salts and sulphuretted hydrogen, giving it a very disagreeable smell. If the coal was highly sulphurous it contains also sulphurous acid in solution, and in the presence of air this may undergo oxidation and give rise to the production of sulphuric acid. This water must, therefore, never be allowed to flow through piping or into receptacles of zinc, for these would be immediately attacked. Even iron will be rapidly affected if the proportion of sulphuric acid contained in the water is at all considerable. In order to avoid the escape of the unpleasant odors it is well to provide the receptacle in which the water from the scrubber is received with a siphon overflow. It is also a good plan to cover this receptacle with a floating layer of oil, which prevents the odors from escaping to the outer air. In the case of installations outside of city limits, where there are no drains, necessity often compels the running away of these waters through open channels. From this may result a disengagement of offensive odors which may give rise to damage suits from the neighbors. The possibility should never be lost sight of when the location for a producer-gas motor plant is under consideration.

Water supply for the vaporizer is usually drawn from the pipe which supplies washing water to the scrubber. Whatever arrangement may be adopted, the whole piping system should be easily accessible, and should be provided with all stop cocks necessary for control of the circulation or for drainage of parts exposed to frost and for enabling emergency supplies of water to be taken off through hose.

Piping for Gas Supply and for Exhaust.

In small gas-engine installations, especially in city neighborhoods, the motor is usually connected with the city gas pipes, thus making it unnecessary to fire the producer when power is required for a few hours only. Consideration must therefore be given to the supply piping to the motor from the city gas mains and to the piping for the exhaust. So far as producer-gas is concerned, the piping has been considered as part of the generating apparatus and has been discussed under that head in preceding sections of this article.

A piping system for illuminating-gas supply to a motor should be most carefully installed to avoid all leakage. Drain cocks must be put in wherever water might accumulate. The supply pipes should be large enough to insure full supply to the motor with gas at the minimum pressure of 20 millimetres at the consumer's side of the meter. The fall in the pipe should be towards the meter to facilitate the collection of condensed or entrained moisture.

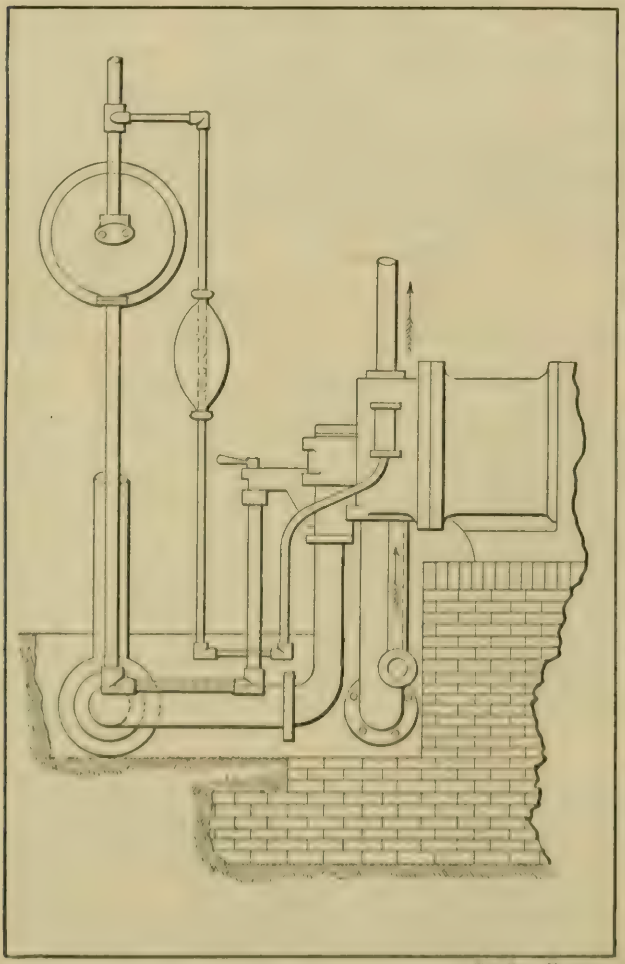

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FIG. 29. PRESSURE EQUALIZING BULB ON GAS PIPING.

It is well to place on the gas pipe close to the motor, either a pressure-regulating valve or a number of chambers so that the operation of the motor shall not cause any pulsations of pressure in the adjoining pipes. If flame ignition is used for firing a charge in the motor cylinder, the supply pipe for that apparatus should be fitted with a rubber bulb so that the suction of the motor does not interfere with the working of the igniter. Figure 29.

Exhaust.—The exhaust pots are generally placed underground in a conduit as near as possible to the motor. In cases where special precautions must be taken to silence the noise of the exhaust, in order to avoid complaint from neighbors, multiple exhaust pots may be used or a muffler may be placed at the end of the conduit. All joints should be easily accessible and made solely with asbestos. The exhaust piping must always open freely to the air. It must never be led to a chimney or a sewer or drain. Many accidents might be cited, due solely to this vicious arrangement. The joints of the exhaust piping should permit free expansion without danger of breakage.

STARTING APPLIANCES.

A gas engine does not permit of starting with the same facility as a steam engine. Special appliances are necessary. These must be so efficient and so easy of handling that one man may always be able to start the engine without pulling on the fly-wheel, while still keeping the driving belt on the unexcited dynamo or on the idler of the driven shaft.

Among starting devices, English constructors particularly have favored a special pump which permits the introduction into the cylinder of a compressed mixture of air and gas, which is then exploded in order to start the motor. I am not partial to this system, especially for motors exceeding 50 horse power, because it has the disadvantage of submitting parts of the machine which are at rest to the shock of a violent explosion. Furthermore, where the engine is supplied with producer gas this type of pump has not given thorough satisfaction, and thus constructors who have persisted in its use have been compelled to resort to the employment of benzine vapor. The one great advantage which may be invoked in favor of the system is that it permits indefinite repetition of the starting operations, if, for any reason, immediate success has not been secured.

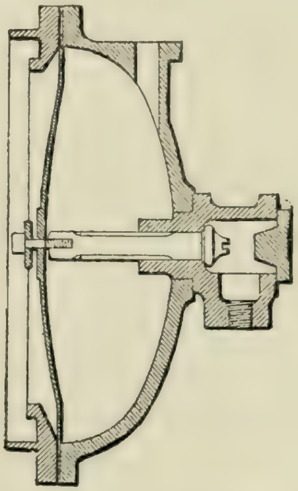
FIG. 30. DIAPHRAGM PRESSURE REGULATOR.

The mode of starting which seems most rational to me is that which depends upon the use of compressed air. For motors of less than 40 horse power the air may be compressed in its reservoir by means of the engine itself at the time of stopping. Above this size it is preferable to use an independent compressor driven by a suitable transmission, which charges the compressed-air reservoir while the

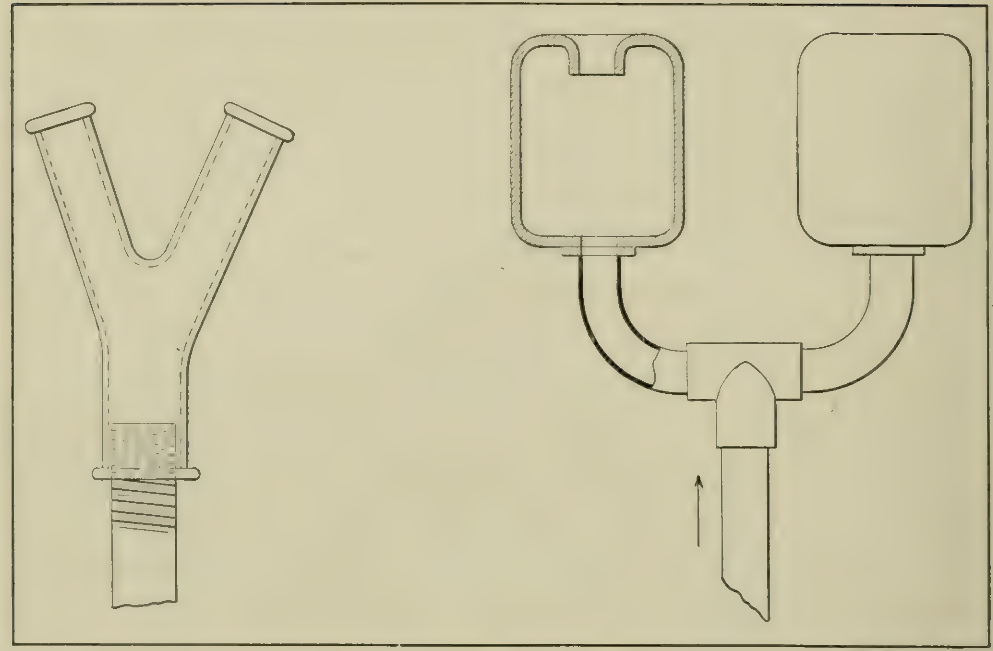
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FIG. 31. ARRANGEMENT OF EXHAUST PIPING AND MUFFLERS.

motor is running. Lastly, for installations of 150 to 200 horse power or more, it is well to install a producer driven by a small independent motor using benzine or city gas. The compressed-air tank should be large enough to serve for at least four successive starting operations without allowing the pressure to fall below four atmospheres. It should, of course, be properly fitted with gauges, valves, and cocks It should be so thoroughly tight that the pressure of the contained air will remain constant for several days. Finally, special precautions should be taken to prevent any entrained oil from passing into the air tank or into the motor, and to subdue excessive noises due to the suction of air by the compressor.

Conclusions.

The points laid down in preceding sections and the details given, whether as to construction or installation, evidently are merely general rules, of which modifications may be made in particular cases according to the special conditions attached to each situation. It is for this reason that I have suggested heretofore in the article, and now emphasize, the necessity of consulting a competent engineer before finally determining the choice of apparatus, and before settling the arrangements relative to its installation.

THE RAILWAYS OF THE UPPER CONGO.

By Demetrius C. Boulger.

There have been some very distressing reports of matters connected with Belgium's exploitation of the Congo. The situation is perhaps too remote and too "opaque" for an inerrant opinion to be formed by the public. Meantime it may be of value as well as interest to study this thoroughly well informed and friendly estimate of Belgian enterprise and achievement in pushing the railway across Africa, from the western coast toward the great north-and-south artery of the Cape-to-Cairo line.—THE EDITORS.

THIRTY years ago the heroic Stanley emerged from Dark Africa, and almost the first declaration that he made about his marvelous discoveries was that he did not value the Congo region at a dollar until and unless a railway connected the ports at the mouth of the river with the navigable portion above the cataracts. That is long ago as the world moves nowadays. But everything that has happened since has confirmed the foresight of the great American-English explorer. The story of railway construction in the Congo State is really a romance that would fill a volume, although railway undertakings are still only in their infancy in the African Continent. It seems to be forgotten by some of our latter-day critics that the Berlin Act, which is so often invoked by persons who have evidently never read it in its entirety, laid down in one of the sections of its first article that the construction of railways was to be undertaken chiefly with the view of abolishing human portage. Although twenty-two years have elapsed since the signature of that Act by fourteen Powers, not one of the five holding territory therein has constructed a single mile of railway in the Congo basin, except the Congo State.

The Congo Government having accepted a clear responsibility in this matter set about devising a regular system for dealing with the question which was the equal concern of the four other territorial powers and itself. It drew up a definite plan of procedure, and in the first stage, considering the limited resources of King Leopold, and the still more limited interest of all outsiders in the situation in Central Africa, it is scarcely surprising that the construction of railways found no place whatever in its original programme. The first point upon which the Congo Government decided to take action was with regard

THE LOCOMOTIVE IN THE JUNGLE.

to the utilisation of water communication on the main stream of the Congo above the cataracts and on its affluents. For that purpose small steamers were sent in section overland to Stanley Pool, where unbroken river communication presented itself for over 800 miles to as far as Stanley Falls. The first of these steamers (and it was a very small one of only 5 tons), was launched on Stanley Pool in December, 1881, three years before the Berlin Conference began its session. During the subsequent twenty-five years the State has been steadily increasing the number and the tonnage of its steamers on the Upper River which today is navigated in a regular manner by a service of steamers of over 500 tons each. But King Leopold had taken good note of the warning of Stanley as well as the provisions of the Berlin Act to which he was in a double sense a signatory, first as King of the Belgians, and secondly, by subsequent adhesion, as

Sovereign of the Congo State. He knew that the railway must come and that only by the railway would his enterprise prosper.

He did not let the grass grow under his feet, once he became ruler of the Congo, for in March, 1887, he granted a concession for the construction of a railway from Matadi, the ocean port on the Lower Congo, to Leopoldville, the river port on Stanley Pool. It would take us too long and too far from our main purpose to describe the construction of this particular line, but no one acquainted with the facts will deny that it was a Titanic achievement carried through under every sort of discouragement. At one stage the project was bankrupt, and outsiders may have rejoiced at the seeming failure of an undertaking which was essential to the foundation of a great Belgian colony in Central Africa. If this project had failed in 1890, as seemed only too likely, there can be no doubt that no matter what vigour and wisdom King Leopold might have displayed in encountering the difficulties before him, they would have proved too great for him in the long run, and complete failure would sooner or later have attended his attempt to found a great national colony. At this critical juncture Belgium came to the aid of its sovereign, and for the first time the personal undertaking assumed a national importance. It was not, however, until 1898, more than eleven years after its inception, that this short line of little more than 225 miles became available for traffic. Students of Central African conditions had fully realised the evils resulting from the employment, often more or less forced, of the African natives as carriers, and the construction of this line with its compulsory portage of the materials necessary for its construction and of the supplies necessary for feeding the men who were building it, brought out the evil in still more glaring colours. But were not these evils inevitable, and the price that had to be paid for a great and highly beneficent result? Let us look to the sequel. Since the construction of what is called the Lower-Congo railway, portage has ceased to be known throughout the whole of the Cataracts Province.

The same difficulty that had presented itself to the pioneers of civilization in the Lower Congo and that had been successfully overcome in the manner described by the construction of the Matadi-Leopoldville railway, confronted the Government in the region of the Upper Congo where navigation was also arrested at more than one point by the presence of cataracts. The first of these obstacles occurred at Stanley Falls near the town of Stanleyville, and above this point portage was the only means of carriage either up stream to Katanga or across the forest to Mahagi and Lado on the Nile. Yet although it was known that the Upper Congo continued to be navigable for many hundred miles above Stanley Falls, save of course for the distances occupied by the cataracts, nothing could be attempted towards utilising it until the line had been constructed from the port with access to the open sea to the point at which the river became really navigable in Stanley Pool. It was not merely that all available resources were locked up in the construction of that line, but as a matter of fact the requisite machinery and rolling stock for the construction of similar lines in the interior could not be sent forward. Portage was, therefore, the only means of carriage and conveyance available in the Upper Congo, and the application of a solution had to wait its turn. Still every one knew that a better and cheaper means of transport must be obtained.

This has always been the case in virgin territory. In America, the waggon team preceded the Pacific Express, and more recently in British Africa the pioneers in Rhodesia and Uganda were followed by long bands of natives carrying on their shoulders and on their backs the stores and impedimenta of the expedition. The Congo authorities have had to adopt the same means under the same conditions in the vast region subject to their sway. It is necessarily a somewhat harsh method, accompanied with a considerable amount of severity, and no doubt attended occasionally by a certain amount of sickness and mortality. But these consequences are the common accompaniment of the early stages of colonisation in an unexplored and unreclaimed region, no matter what may be the Continent or what the flag under which the advance guard of the colonising or conquering Power moves towards its goal. They are a passing phase, however, as it is clearly to the interest of the ruling State, quite apart from humanitarian motives, to provide as soon as possible a more expeditious, economical and, let me add, popular means of conveyance than the employment of human carriers. No Government could have shown more clearly than the Congo State that it realised that portage was a system to be superseded by something better in the Upper Congo region as quickly and as effectively as had been done in the Lower Congo.

In 1898, the year of the official opening of the line to Stanley Pool, the question entered upon its third stage. Orders were issued for the survey for a railway from Stanleyville to the Nile, and for the preparation of careful reports and charts throwing necessary light on the extent and position of the navigable sections of the

MOVING DIRT FOR CUT AND FILL WORK.

river above Stanley Falls. While these preliminaries were being attended to, the Congo Government devoted its principal efforts to the improvement of its flotilla on the river above Stanley Pool. During these years many 500-ton river steamers and cargo boats of the same tonnage drawn by powerful tugs were placed on the main stream, while repairing slips and dry docks were constructed near Leopoldville on the lake. These details show the thoroughness with which the Congo administration set itself to the task before it. By the time all these arrangements were completed for sending forward expeditiously and cheaply the machinery, implements, and rolling stock needed for the construction of railways at a distance between 1,000 and 1,200 miles from the sea, the plans of the Government had acquired greater clearness and consistency.

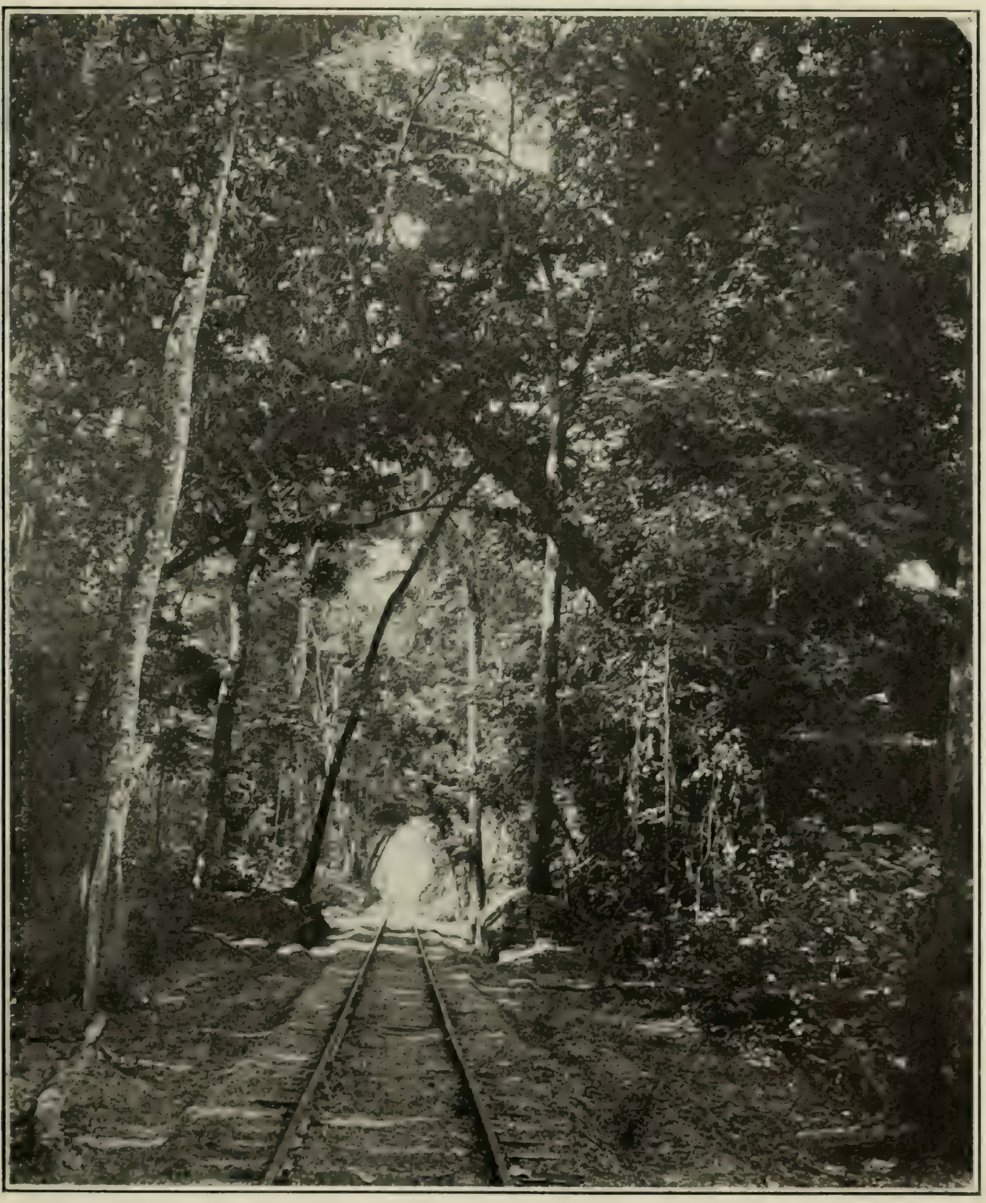
Owing to ulterior considerations of a political order, among

BRIDGE BUILDING ON THE CONGO RAILWAY.

which the unsettled state of the Lado question was not the least important, the surveyed line from Stanleyville to Mahagi was dropped. A definite scheme for filling up the gaps in the river navigation by short lines of railway wherever cataracts intervened was adopted. This plan was decided upon owing to the discovery that except for those gaps the Upper Congo continued to be navigable for many hundred miles, far into the great southern province of Katanga.

In January, 1902, a concession was granted to a company formed specially for the purpose, under the title of "Company of the Railways from the Upper Congo to the Great African Lakes," for constructing lines of railway from the Upper Congo to Lakes Albert and Tanganyika; but this portion of its programme has been left in abeyance pending the execution of its more immediate and necessary task up the Congo River itself. An official decree issued subsequently to its original charter conferred on this company the right and task of building one line to turn the cataracts at Stanley Falls, and a second line to turn the cataracts of Sendwe and Hell's Gate. For the sake of clearness it may be stated that the two lines in question are those from Stanleyville to Ponthierville, and from Kindu to Buli. The first of these lines is completed and in working order. The second line has been begun and is progressing with remarkable rapidity.

The starting point of these railways is Stanleyville, a picturesque and growing town on the left bank of the main Congo river, situated at an altitude of about 1,400 feet above sea level. The first half of the line rises steadily and slowly to a maximum altitude of 1,750 feet. The second half is an equally gradual descent to Ponthierville which is less than 1,550 feet above sea level. Except for this very small ascent and descent the construction of the railway presented no features of great difficulty. As, however, the track passes through a dense forest, it was not easy to determine which was the best line to follow. The clearing of the forest has been accomplished for a very few yards only on each side of the rails. Certainly the most



A CHARACTERISTIC SECTION OF THE LINE ON THE CONGO RAILWAYS.

serious part of the work was the cutting of the track through the wood and undergrowth owing to the fact that the timber could not be burnt on the spot but had to be carried into the open. A further cause of difficulty was the eradication of the roots and undergrowth, while numerous watercourses required either extensive draining and the construction of culverts, or, at certain points, the building of bridges. However, none of these last named was of any important dimensions. Out of the twenty constructed only ten exceeded 50 yards in length. The embankment part of the undertaking also was easily accomplished owing to the absence of rock and to the fact that plenty of earth, including good clay and rubble, was available.

PULLING A STEEL BRIDGE INTO PLACE.

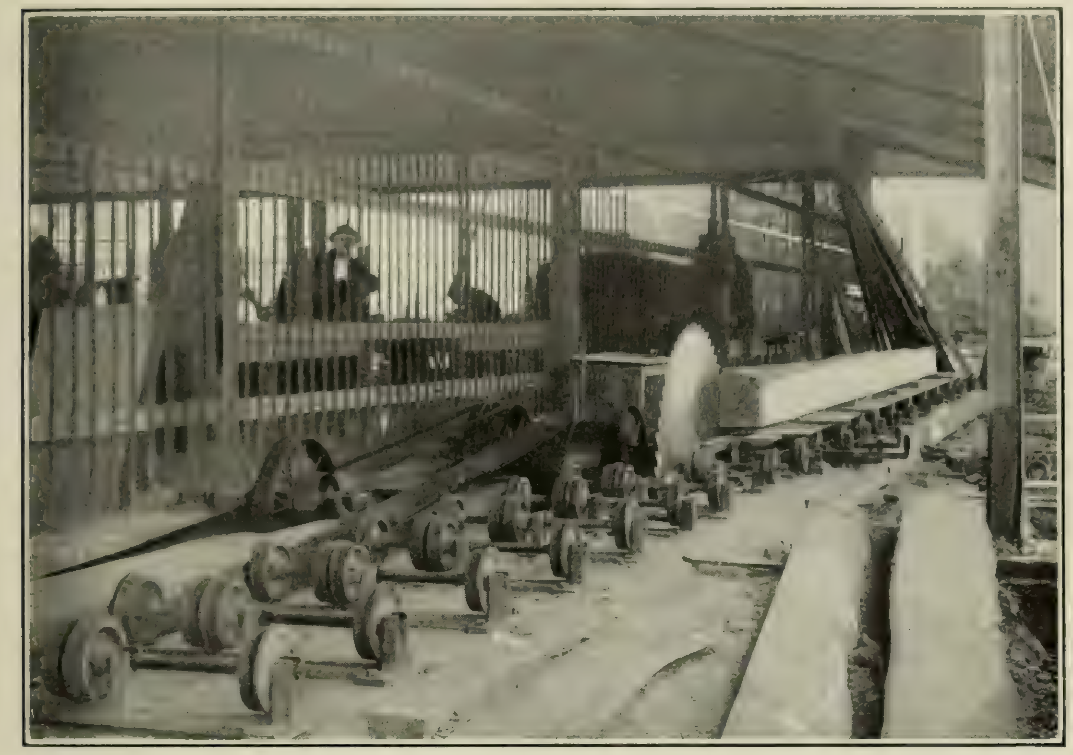
One of the most interesting subjects in connection with this enterprise was the organization of the necessary labour. It must be remembered that the labour was taken from the local people and not imported. Consequently they had no experience of railway construction, although some of the men had become proficient masons and bricklayers on works at Stanleyville which included a very fine and substantially built quay on the river bank. The Belgians organised their labourers into small parties of between 20 and 30 and entrusted the control of each group to a "nyampara" which in this case may be translated foreman. Over every hundred labourers was placed an European foreman. With regard to the payment of the men, the first experiment of paying them by piece work failed. It was also found impossible to employ them on extra work, for they could not understand that to obtain the extra payment they had to do extra work. It was found that under personal supervision they worked well, but with the supervision withdrawn they did not work at all. In consequence a fixed weekly wage had to be adopted. On this point I do not think better evidence can be given than by an American gentleman, Mr. William Edgar Geil, who made a very interesting tour in Central Africa in 1905 which is described in his work entitled "A Yankee in Pigmy Land," published last year. The following passages I quote from his volume: . . . .

> "While in construction of the 'chemin de fer du Congo' certainly hundreds have lost their lives, and I have no doubt thousands, yet in the long run it will prove to be of great value in saving human life. It is also a great saving of human health. The old caravan route was flanked with the graves of carriers and of whites who fell by the way, and diseases were developed by the journey. Now many sufferings are avoided. Before the railway was opened the journey took twenty days at a cost of £50. There is now a great saving of time and the trip costs only £2. This is a prodigious saving, and with regard to the Great Lakes' railway it is not only a great material help, but also furnishes a new idea to the whole native mind; not simply to those living in proximity to the line, but to millions of natives that have heard rumours of this strange mode of transportation. A gentleman on the spot told me that the history of the whole Upper Congo is divided into two parts, that before the building of the railroad and that since.
>
> "With regard to the works of the Great Lakes' railway, 2,300 native workmen are employed and but 30 whites. The savages receive from four to twelve yards of cloth per month, besides rations of a pound of rice per diem, two pounds of American salt beef per week, a half pound of salt per week, with bananas as often as the Government is able to furnish them or the blacks are able to steal them. They also receive one shoka per week. Now the shoka is the local spear-shaped iron currency of the region. With this they can purchase manioc or some of the little but terrible delicacies so dear to the native heart. The employees work from 6 to 11 in the morning and from 2 to 5.30 in the afternoon. Besides the unskilled labourers there are five coast carpenters and ten masons come from Sierra Leone and Accra. I carefully scrutinized the native employees, and found them strong, robust and jolly. Each wears a medal bearing his number, making it possible easily to trace an individual. These decorated savages wear considerably more clothing than the general run of natives. Indeed they impressed me as being prosperous and well satisfied with their employers, their employment and their wages."

Mr. Geil speaks of 2,300 natives being employed on the works, but in the final stage of the enterprise, which was not reached until a year after his visit, this total had risen to 4,000. When a large number of men are thus brought together within what may be termed a contracted area it is not uncommon to have an epidemic of some kind or other, but during the three years of active work no serious sickness prevailed, and the mortality was very low. Among the Europeans it was slightly higher, and out of a total of 292 white men—engineers, overseers, etc.—19 died and 44 were invalided. Something of the good health and good conduct of the black workers must be attributed to the fact that a very large number amongst them were Christians, and consequently more or less civilised and acquainted with the laws of sanitation. To exercise a certain moral supervision over their congregation as well as to provide them with the means of practising their religion a chapel was opened on the line of route, and moved forward with the succeeding stages of the work.

The line from Stanleyville to Ponthierville—a distance of 80 miles—begun in January, 1903, was completed in March, 1906, but the official opening was not celebrated till September 1 of that year. The immediate consequence of this achievement was that steamers, tugs, and cargo boats were sent over the line to Ponthierville and launched on the Upper Congo or Laulaba, which here presents a navigable stretch of 195 miles up stream. After these boats had been floated, and communication by water fully established, the whole personnel, native and European, of the first railway were conveyed to Kindu where the second and more considerable part of their task awaited them. As soon as the work was done at Ponthierville and the means of conveyance provided, the men were despatched without waiting to take part in the ceremonies and functions of the official opening. Indeed, before that date was reached the second railway was well advanced so far at least as organisation at its base went.

The railway south of Kindu was taken in hand under much more favourable conditions than its predecessor. In the first place the native staff, instead of untrained and inexperienced men, was by this composed of seasoned and capable labourers. Their numbers had also been increased. Whereas the Ponthierville line was begun with only 2,000 men that from Kindu has been commenced with a staff of not less than 5,000. The improved means of river navigation have also enabled the authorities to send forward heavier machinery and girders, and this fact has undoubtedly simplified the task before the Belgians above Kindu. Indeed, the very first section out of that place could not otherwise have been constructed, for the line had to be carried over a marsh by a steel viaduct for a distance of 200 yards. This part of the work has been already finished, and the latest information is to the effect that the embankment work is far advanced, and that the rail head has reached kilometre 30 out of a total of 320 kilometres. Although this line is more than twice as long as that to Ponthierville, it is confidently expected that it will be finished by 1909.



A CONSTRUCTION SHOP ON THE UPPER CONGO.

While these important works on land are in progress a scarcely less important task on the river is in hand. The navigable channel from Ponthierville to Kindu has been greatly improved by the removal of many rocks by dynamite and by the employment of a heavy dredger (sent out from the Scheldt) where the water seemed dangerously shallow for the larger steamers. In the upper section of the river above Buli a hydrographic commission has been working for some time on a survey of the navigable channel of nearly 400 miles above the cataract called Hell's Gate. Some weeks ago this party had reached Lake Kisali, which is situated on the eighth degree of south latitude. The report from the leader of the survey party stated that so far as this point this stretch is the very best navigable channel in the whole course of the river above Leopoldville. It seems probable that a navigable channel will be found through Lake Kisali itself without any difficulty, but before accepting this as a fact it will be necessary to await the full report of the survey. In any case it is proved that a new route by land and water is being opened up for a distance of not less than 860 miles above Stanley Falls, and already 300 miles of it are open to traffic.

What the Belgians have accomplished with regard to the Congo is that they have supplemented the defects of nature and vanquished the obstacles that rendered navigation on the great river of dubious value. By the railway in the Lower Congo they placed the Upper River in direct communication with the ocean and thereby with the outer world. By the two railways that I have described in this paper they have evaded and turned the obstacles which were assumed to render the river useless as a waterway above Stanley Falls. They have thus ensured the prolongation of the magnificent water route which traverses their territory in its first portion from west to east, and in its second from north to south. It is this that constitutes the real source of the present prosperity and the future and much increasing prosperity of their colony. An important German technical publication, *Stahl und Eisen,* concludes from the achievement that "We Germans have much to learn from the farsighted colonial policy of the Belgians in the matter of ways of communication."

It is rather a remarkable and significant thing to notice how cordially and candidly the Germans are expressing their appreciation of the work done by the Belgians in Central Africa which presents such a striking contrast with the harsh criticism and general depreciation that the same subject receives at the hands of some English critics. I cannot conclude this brief paper in a better way than by quoting another German opinion which appeared in a recent number of the very interesting publication called *Weltwirtschaft*:—

> "This new and glorious stage arrived at by Belgian engineers in the imposing development of ways of communication in the Congo Free State marks a further step towards the suppression of human portage. The Government is aiming at suppressing portage and as it has not been able to do so immediately, it has very wisely endeavoured to abolish this burden on the most congested routes. This is especially the case with the Katanga route. The Katanga, with its rich mineral deposits, its fertile soil, and healthy climate, has every prospect of becoming one of the large centres of European activity. The creation of a steam communication between this region and the sea is wise administrative policy, since it affords the actual commercial movement a possibility of full development without turning away the natives from their usual occupations. Far from becoming human beasts of burden carrying heavy loads on the roads, the natives will continue to work on the fields and mines."

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By C. U. Carpenter.

VI. METHODS FOR FIXING STANDARD TIMES FOR MANUFACTURING OPERATIONS.

Mr. Carpenter's series began in January, and the five articles heretofore presented discussed, first, the general methods of examining into the condition of any manufacturing business so as to discover the existence of waste and loss and to determine the "sticking points"; second, the nature and the working of the "committee system" of factory administration; third, the reorganization of the designing and drafting departments; fourth, the great importance and value of the tool-room as a source and spring of profitable methods; fifth, the general conditions necessary for manufacturing at minimum cost. The installment now presented covers the most central point in machine-shop management—the effective operation of the tools themselves. A following and supplementary paper in August will show how the methods for determining "standard times" for machining can be adapted to standardizing the assembling of work, and how the times so fixed can be introduced into routine operation in the shop.—THE EDITORS.

ASSUMING that we have determined upon standard shapes and have the proper facilities and men for the forging, hardening and grinding of tools properly, we now come to the consideration of the question of making such experiments as will make it possible to determine with a high degree of accuracy just what the shop ought to be able to accomplish in the way of production with the existing equipment.

The first problem that confronts the factory manager is how to start to make the tests on the bewildering number of pieces used in the manufacture of his particular product. The warning should be issued that unless the work of testing is done systematically much of it will be done without avail and great loss of time will follow.

Classification of Parts.—I have usually found it possible, and strongly advisable, to divide into groups or classifications the parts which are to be manufactured according to these new methods. The first separation which would occur to any one would be that according to the quality of metal used. The second grouping will depend altogether upon the article that is being manufactured. Generally it will be found perfectly practicable to make a second series of classifications depending upon the similarity of design, shape, and mechanical operations necessary. Of course where parts are of the same genus but of different sizes, this is a comparatively simple proposition; but it will generally be found upon analysis that even a further classification can be made under which these groups can be still reduced by considering, as stated above, design and similarity of operation.

I have in mind one shop which required in the course of building, assembling, and making the machines the production of some 9,000 parts. However, by a thorough system of analysis and classification, it was found possible to group these 9,000 parts into less than 250 classifications. It was thus possible to get a clear idea of what should be accomplished on these 9,000 pieces through the results of the 250 tests made in a thorough manner. While it was probably true that the deductions made from these tests were not in all cases as thorough as would have resulted from individual tests, at the same time this plan simplified a tremendous problem and enabled the concern to get a much quicker start on the right road than if a haphazard method of testing these 9,000 pieces had prevailed.

In studying the question of production in regard to any tool, we must consider not only the efficiency of the machine tool and the cutting tool, but also the time that it takes to set up the job on the machine tool in the first place. It is quite probable that a critical examination of the way of setting up the work usually practised will prove that the method used is capable of alterations which will result in a surprising saving of time. A thoroughly scientific method of setting up the job usually results in a saving of 30 to 50 per cent in the time required by the average workman. It is therefore necessary to study this question at the start, as the test is being made, and prepare a list of instructions giving the different operations required in detail and the length of time that should be taken under ordinary conditions to accomplish this job of setting up. This determination of setting-up time should not be left for future tests, but should be done right at the beginning, for if it is not done then, the chances are it never will be done. It is easier to do it at the time of the test than at any other time.

Again, we must consider the time required to handle the parts, especially if they be small so that they can be clamped in and taken out of the machine tool in the shortest possible space of time. A thorough study of this one problem should be made at this particular period. The importance of this is much greater than is usually apparent, especially on parts of small dimensions.

A short time ago, I noted with particular care a workman operating a lathe on a large number of small pieces in a shop where the manufacture of small parts prevailed. The machine tool itself was well speeded up and the production was quite rapid. It was an actual fact, however, that the time consumed by the workman in taking out his finished piece and fastening in the machine tool the piece to be worked upon, exceeded by quite an appreciable percentage the actual length of time required for the machine operation of cutting.

While this may to the inexperienced man seem to be insignificant, at the same time the determination of these points is of the greatest value, especially under such conditions as outlined above, because of the fact, as stated before, that "time is what we pay for." Everything possible should be done to cut down that element of time all through the shop processes.

Before starting any tests, care should be taken to see that there is provided a cut meter for measuring the cutting speeds, that the belts are all in good condition, and that the proportion of pulley speeds is carefully checked up. The depth of cut should be very carefully measured, and, as stated before, care should be taken to see that you have tools of uniform character and plenty of them. Even at risk of reiteration, I want to emphasize the importance of this provision being made in advance.

Whatever the condition of your shop and whatever the system of management, it is altogether probable that an expert tester will be absolutely necessary. This man should be one who is totally removed from the influence of the foremen or any of the workmen. He should when possible be placed in some part of the factory where he can work practically unobserved and certainly undisturbed. Wherever his tests are made—specially or in the shop—his reports should be carefully checked up and should be invariably sent to the head office, he being given to understand that he is responsible to the officers alone. The importance of having an expert of this character lies not only in the necessity of securing accurate tests upon which you can depend, but also upon the absolute necessity of training up some man who can properly analyze the possibilities of production, fill out the proper instructions, and be in a position to see, as speed boss, that the men are thoroughly informed as to the methods to be adopted in proving the results which his tests show possible. It is absolutely necessary that you be in a position to demonstrate to your workmen that work *can be done* in the time set for it, by actual demonstration. No one can do this better than this expert tester, and no one would be in a better position to show the workmen how to accomplish the result himself. A man in this position should not only have a high

Practical Table of Cutting Speeds in Lathe Work, on Cast Iron, in Feet per Minute.

Tools to be Reground Every 90 Minutes.

Depth of Cut.	Feed, Inches.	1-Inch Tool. Soft.	1-Inch Tool. Medium.	1-Inch Tool. Hard.	¾-Inch Tool. Soft.	¾-Inch Tool. Medium.	¾-Inch Tool. Hard.	½-Inch Tool. Soft.	½-Inch Tool. Medium.	½-Inch Tool. Hard.
3/32	1/64	226	113	66.0	222	111	65.0	206	103	60.0
	1/32	177	88.4	51.6	169	84.3	49.2	147	73.3	42.8
	1/16	130	64.8	37.8	120	59.8	34.9	97.5	48.8	28.5
	3/32	107	53.5	31.2	97.0	48.5	28.3	76.0	38.0	22.2
	1/8	92.8	46.4	27.1	83.4	41.7	24.4	64.1	32.1	18.7
	3/16	75.7	37.8	22.1	66.4	33.2	19.4	....	....	....
1/8	1/64	205	102	59.8	203	102	59.3	194	97.0	56.7
	1/32	160	85.1	46.8	156	78.2	45.6	138	69.3	40.4
	1/16	118	58.8	34.3	110	55.0	32.0	93.1	46.5	27.2
	3/32	97.0	48.5	28.3	88.8	44.4	25.9	72.1	36.1	21.3
	1/8	84.2	42.1	24.6	76.2	38.1	22.3	41.8	20.9	12.2
	3/16	68.6	34.3	20.0	60.9	30.4	17.8	....	....	....
3/16	1/64	181	90.6	52.9	181	90.6	52.9	182	91.0	53.0
	1/32	142	70.8	41.3	137	68.5	40.0	128	64.0	37.7
	1/16	104	51.9	30.3	97.7	48.9	28.5	86.1	43.1	25.1
	3/32	85.8	42.9	25.0	78.0	39.0	22.8	67.4	33.7	19.6
	1/8	74.3	37.2	21.7	67.5	33.7	19.7	....	....	....
	3/16	60.6	30.3	17.7	54.2	27.1	15.8	....	....	....
1/4	1/64	165	82.3	48.1	167	83.6	48.8	173	86.3	50.4
	1/32	129	64.4	37.5	126	45.4	26.3	81.9	41.0	23.9
	1/16	94.3	47.1	27.5	90.8	63.2	36.9	122	61.0	35.7
	3/32	77.8	38.9	22.7	72.7	36.3	21.2	....	....	....
	1/8	67.5	33.7	19.7	62.7	31.3	18.3	....	....	....
	3/16	55.0	27.5	16.1	.....	....	....	....	....	....
3/8	1/64	143	71.5	41.8	150	75.0	43.8	....	....	....
	1/32	112	56.0	32.6	113	56.7	33.1	....	....	....
	1/16	81.9	41.0	23.9	81.0	40.5	23.6	....	....	....
	3/32	67.6	33.8	19.7	65.5	32.7	19.1	....	....	....
	1/8	58.6	29.3	17.1	.....	....	....	....	....	....
	3/16	57.5	28.7	16.8	.....	....	....	....	....	....
1/2	1/64	132	66.2	38.6	.....	....	....	....	....	....
	1/32	104	51.6	30.2	.....	....	....	....	....	....
	1/16	75.8	37.9	22.1	.....	....	....	....	....	....
	3/32	62.6	31.3	18.3	.....	....	....	....	....	....
	1/8	54.2	27.1	15.8	.....	....	....	....	....	....
	3/16	44.2	22.1	12.9	.....	....	....	....	....	....

degree of ability as a mechanic, but should also possess a goodly amount of tact.

TABLE OF PLANER SPEEDS ON BESSEMER PLATES.

Planer Number.	Speed in Feet.		Feed on Different Thicknesses of Plates in Inches.			
	Cut.	Return.	1	¾	½	⅜
1—(82)	19	77	.06	.09	.12	.18
2—(767)	30	97	.03	.045	.06	.09
3—(793)	30	88	.03	.045	.06	.09
4—(96)	22	45	.05	.075	.1	.15
5—(107)	22	45	.05	.075	.1	.15
6—(98)	28	52	.036	.055	.062	.11

Tool to be ground at the end of one hour and thirty minutes on the Bessemer plates.

The tables presented on pages 586-589 show the best results, to my knowledge, to be obtained on first-class machine tools, such as lathes,* planers, shapers, drilling machines. Without some such standard guide, the proposition of making a series of standard-time tests in the ordinary factory is indeed a very difficult one. The results shown in the tables may not in all points prove to be the limit as far as production is concerned; but they represent the best so far obtained, and are far in excess of those usually secured, so that they can be safely used as a basis upon which to work and they make the determination of the best time in which a job should be done a comparatively simple matter, as concerns the machine work alone. Inasmuch, however, as they were obtained under first-class conditions, the state of the existing machinery in the average shop will render a modification of these rules and tables quite necessary. It is for this reason that the investigation of existing machinery (referred to in the preceding article) must be undertaken first, and the tabulations so modified as to apply to the existing circumstances.

By the use of tables on lathe work similar to those prepared by Mr. Taylor, I have been enabled in several cases to make large reductions in the force of machine hands. In one instance several years ago, the introduction of a speed boss skilled in the use of these data resulted in cutting down a machine force of 63 men to 22 men within a period of 3½ weeks. In another case, a reduction of over

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* The data on lathe work represent the result of experiments made by Mr. F. W. Taylor and his associates and were presented before the American Society of Mechanical Engineers in his paper on the Art of Cutting Metals. The data are presented with Mr. Taylor's consent and are the most comprehensive and valuable of any so far presented to the manufacturing public, to my knowledge. The data confirm throughout in a very striking manner the experiments performed in factories under my direction. They are, however, more complete than the tests made under my supervision.

Our tests on lathes, planers, punches and dies were made with both the Novo high-speed steel of Herman Boker, N. Y., and the Bohler new rapid steel of Houghton and Richards, Cleveland, Ohio, from both of which we have secured most excellent and uniform results. The drilling data were compiled from a series of tests made in our own shops with drills manufactured by the George H. Rich Manufacturing Co., Buchanan, Mich. The tests on planing and drilling tools were made under the direct supervision of the factory manager of the Herring-Hall-Marvin Safe Co., Mr. E. E. Watson.

PRACTICAL TABLE OF CUTTING SPEEDS IN LATHE WORK, ON STEEL, IN FEET PER MINUTE.

TOOLS TO BE REGROUND EVERY 90 MINUTES.

Depth of Cut in Inches.	Feed in Inches.	1-Inch Tool.			¾-Inch Tool.			½-Inch Tool.		
		Soft.	Medium.	Hard.	Soft.	Medium.	Hard.	Soft.	Medium.	Hard.
3/32	1/64	490	245	111	482	241	110	445	223	101
	1/32	339	169	77.0	323	161	73.4	281	141	63.9
	1/16	235	117	53.4	217	108	49.3	177	88.7	40.2
	3/32	189	94.5	43.0	172	85.8	39.0	135	67.4	30.7
1/8	1/64	427	214	97	423	212	96.1	404	202	91.8
	1/32	296	148	67.2	284	142	64.5	255	128	57.9
	1/16	205	102	46.6	190	95.2	43.2	161	81	36.6
	3/32	165	83.0	37.5	151	75.3	34.2	....	....	....
	1/8	142	71.0	32.3	128	63.8	29.0	....	....	....
3/16	1/64	358	179	81.3	358	179	81.4	359	179	81.6
	1/32	247	124	56.1	240	120	54.5	226	113	51.4
	1/16	171	85.5	38.8	161	80.5	36.6	....	....	....
	3/32	138	69.0	31.3	127	63.7	28.7	....	....	....
	1/8	118	59.0	26.8	...	....	....	....	....	....
	3/16	95.0	47.5	21.6	...	....	....	....	....	....
1/4	1/64	315	157	71.6	320	160	72.7	330	165	25.0
	1/32	218	109	49.5	215	107	48.8	....	....	....
	1/16	150	75	34.1	144	72	32.7	....	....	....
	3/32	121	60.5	27.5	...	....	....	....	....	....
	1/8	104	52	23.6	...	....	....	....	....	....
3/8	1/64	263	132	59.8	276	138	62.7	....	....	....
	1/32	182	91.0	41.4	185	92.4	42.0	....	....	....
	1/16	126	62.8	28.5	...	....	....	....	....	....
	3/32	101	50.6	23.0	...	....	....	....	....	....
1/2	1/64	232	116	52.7	...	....	....	....	....	....
	1/32	161	80.5	36.6	...	....	....	....	....	....
	1/16	111	55.7	25.3	...	....	....	....	....	....

50 per cent in a large machining department was secured within 5 weeks of the time these tables had been placed in the hands of an efficient foreman and measures taken to see that stock was furnished to his machines promptly. In another case a simple system of using the tables made it possible to reduce the number of planers from 19 to 13. Even with this reduction, the remaining 13 planers gave a much larger output than had formerly been secured from 19.

TABLE OF SPEEDS AND FEEDS ON DRILLS.

Size, Inches.	Speed.	Feed.
½	430	.018
⅝	330	.019
¾	280	.019
⅞	255	.019
1	250	.020
1⅛	245	.020
1¼	240	.020
1⅜	230	.020
1½	210	.020
1⅝	200	.020
1¾	195	.020
1⅞	190	.020
2	180	.020

Tests made in shops of Herring-Hall-Marvin Safe Company upon cast iron, using drills manufactured by Rich Manufacturing Company, Buchanan, Mich.

A systematic use of the tables on the drilling machines produced even more surprising results. In several cases within my own experience a reduction in prices of over 50 per cent was made possible, and in one particular case a reduction of even 75 per cent.

Of course the possibilities of saving in any one shop would depend upon the production conditions existing at the time the tests and examinations were made, but it is safe to say that large economies will result if such tables can be put in effective use in a manufacturing shop.

I have brought out previously the importance of classifying all of the manufactured parts so that attention can be concentrated upon those which are truly representative of each separate classification. And in determining the best place of attack in the classification it is well to remember that, in the average shop, there is usually at least one point which, through bad equipment or ineffective direction, is practically retarding shop progress throughout. With ordinary foremanship it is almost impossible to discover the existence of such conditions. The Tool Room Committee and the tester, who is destined to become later the speed boss, should therefore first determine the classifications and the best point of attack. After time calculations have been made and approved by the Committee, with the aid of the tables just given, they should be placed on record cards (which will be considered later) to be confirmed by the tester in actual trials.

It is important, however, to note that in the manufacture of either single large pieces or many small parts, there are a number of elements entering into the cost of production, other than that of machining, which are always of sufficient importance to merit the closest consideration. In fact, very often it is the lack of attention to these other factors that accounts for much lost time. This is particularly the case where large quantities of small parts are manufactured, each part in itself requiring but a slight machining operation.

Almost without exception the tables which have been so far presented represent machining of rather large bodies, while in many cases in actual manufacture the problem is one of the turning out of product of small dimensions. The question of "handling time" in this case becomes of paramount importance. This brings us at once to a consideration of the following requirements, all of which must be considered by the committee, whether the pieces or the quantity be large or small:

1.—There must be ample stock delivered to the workman before he stops work upon his preceding job. This is an item of practice which will in itself bring surprisingly large returns in efficient production. In fact, if nothing more were accomplished than the constant supplying of the workman with plenty of stock, under a good routing system, and plenty of good tools of standard shape and properly hardened, the efficiency of the average shop would be increased probably 33 1/3 per cent. This question will be dealt with later, but reference may be made to my articles upon stock system routing and stock tracing—in which particular emphasis is laid upon the stock tracer, his work, and his authority—and upon inspection, etc., in THE ENGINEERING MAGAZINE, May, June, 1902.

2.—The stock must be so placed as to be most easily reached or handled by the workman. This presupposes a *standard place* for the stock. In the case of large, heavy pieces, standard handling devices must be provided.

3.—The clamping devices must be simple, effective, and *standard*, and must be supplied to the workman before he is ready to start. Much study may be given profitably to this point.

4.—The tools must be *standard* in every respect, ground to proper shapes, and must be supplied to the workman before he is ready to start his work.

5.—The jigs, fixtures, punches, dies, gauges, etc., must be so designed as to be handled easily, quickly, and accurately, and must be at the workman's side before he is ready to begin work upon his new job. Much profitable study can be given to the question of proper tools. These tools and gauges must be inspected for accuracy regularly so that the foreman and workman may have full confidence in them.

6.—All stock coming into a department from some other department *must be inspected* before it is placed upon the department platform. Whether the work is large or small, inspection is absolutely necessary. For further details on this matter it may prove of interest to note the rather full treatment of the subject of inspection in my articles appearing in THE ENGINEERING MAGAZINE in 1902.

Full mention is made of these requirements at this point for, while some of them are far removed from the single problem of machining, they still form a most vital part of the "time required to complete a job," and most certainly no "standard" or "shortest" time can ever be reached unless they are considered and *standard methods* in each case installed. And again they must be considered when we attempt to set a "standard time" upon assembling jobs.

ANALYSIS OF TIME REQUIRED.

Granting that these six requirements have been fulfilled, we next come to the consideration of:

1.—The time required to handle the part or parts.

2.—The time required to "set up" the job.

3.—The time required to machine the work (to gauge or drawing).

4.—The time required to remove the work.

In making any study of the time required on these different parts of a job, an accurate stop watch should be used. One with two hands, either of which may be stopped while the other continues to run, is the best type. It is especially valuable in noting the time required for some particular portion of the work itself, by stopping one of the hands and then noting the actual time lost between the essential portions of the operations as shown by the elapsed time indicated by the stoppage of the other hand. This is particularly useful in noting the operations of assembling. Some uniform tabulation in recording experiments or conclusions should be used from the start. The records submitted are suggestive only, but contain the essential points. The proper forms must be evolved for each case. Features non-essential in one concern may be very important in another; e. g., "setting up," a job which in some types of manufacturing may be relatively important, while in others it is a very simple one. The same statement can be made with especial emphasis in regard to machining, particularly as regards the production of stock on automatic machines, such as screw machines, or semi-automatics, such as turret lathes.

The time required to handle the parts is an important consideration, whether the tool be a lathe, planer, mill, punch press, or drill press. An astonishingly large proportion of lost time can be attributed to lack of proper facilities for handling work, lack of methods in handling it, and the tendency of the workman to kill time during the period which offers so good an opportunity. In the case of heavy work it will always pay to have good hoisting and handling facilities over each tool. They may take the form of compressed-air hoists or an overhead single track carrying an electric hoist serving a number of machines—a very economical arrangement. In some cases the use of specially designed magnetic hoists will greatly facilitate such work. Close attention should be paid to the clamping devices, so that little time will be lost in attaching to or loosening from the part. A carefully considered and *standard method* of piling or placing the parts will often enable this clamping to be done very quickly.

In the handling of light work there are several points of importance that must be considered.

Wherever possible the stock should be carried in boxes. These boxes should be standardized so that as few sizes as possible need be used. They should contain tin pockets on the side in which the necessary cards can be placed. In many cases it pays to arrange the boxes with movable shelves so that the stock cannot only be easily handled but can be much better protected in carrying it through the shop. Stock requiring close work is often injured through bruising. Again, such a method makes the removal of the stock from the box by both the machine hand and the inspector much simpler.

Careful judgment should be used in selecting the place where the box shall stand. Very often a low, strong table about the height of the ordinary hand truck will be found advisable. The use of this table immediately standardizes the spot where the stock shall be placed, makes it easier for the truckers to handle the boxes, and, in addition to this, saves the work and time of the machine hand in stooping over to pick the parts out of the box. The placing of these boxes in the same position each time—the fact that the workman becomes accustomed to finding his stock always in the same spot—adds appreciably to the speed of handling.

TESTING RECORDS.

Date
Machine Tool
Cutting Tool

Name or No. of Part
Classification
Quality of Metal
No. of parts tested

Setting Up Time (analyzed).

No. of Parts	Handling Time	Depth Cut	Feed	Cutting Speed	Test No.	Time of Test	Condition of Cutting Tool	Condition of Machine Tool	Quality of Work	GENERAL

Standard Time for Setting Up (see instructions)
Standard Time for Handling Parts (see instructions)
Standard Depth of Cut____________
Standard Feed____________
Standard Cutting Speed____________

Note. Tool to be so speeded that cutting tools will require regrinding at end of 1½ hrs. run if limitations of machine tools will permit.

FORM SUITABLE FOR TESTING RECORDS.

In the space beneath this table there can usually be placed an additional shelf to contain the tool boxes for the different jobs which will be apportioned to the workman.

The Determination of Handling Time.—If this rule of carefully standardizing the place before each machine where stock is to be placed is adopted, the question of determining the handling time becomes comparatively simple. A series of stop-watch tests upon a quick-moving workman will usually be found to be sufficiently accurate. It is well, however, to check this up by actual trial on the part of the tester. Full data relative to each test should invariably be placed upon the record cards.

Setting-up Time.—The "setting" up of jobs on lathes, planers, shapers, milling machines, punch presses, drill presses is so varied that no set rules can be laid down relative to it. A close study of all the conditions under each classification of work is very necessary. Tests should be made with stop-watch observations covering each portion of the setting-up job. When this is first attempted, it will be found almost invariably that the clamping devices for the different tools can be very greatly improved.

If the time of the ordinary workman in setting up certain jobs is noted carefully, and then the same jobs are selected for analyses, very surprising differences between the time that he has required and the time that should be required will be found to exist. It being out of the question for any one man to determine the best methods of procedure in the setting up of jobs, it is therefore wise to submit this entire matter to the Tool Room Committee, calling in to such meetings the several foremen and assistant foremen whose departments are affected. The mere fact of calling men in for such important discussions will lead not only to correct conclusions, but will also act as a spur on them toward the improving of the setting-up conditions on the machines in their several departments. In fact, I am in favor of special men to set up work requiring a particular degree of accuracy. This is particularly so in the case of fine punch-press, die, and milling work. A full record of all the analyses of setting up time should be made upon cards at the time of each test.

The Time Required for the Handling of Work on the Machine Tools.—In the case of large work on lathes and planers, the time of handling the work on the machine tool is of minor importance, inasmuch as the work remains fixed until the machining operations are performed upon it. Conditions, however, are different in the case of drill-press work and punch-press work.

The handling of heavy work under a drill press, where a number of holes have to be drilled at different points in the piece of work, becomes quite a problem. Of course, radial drills are in most cases used for such work. In my opinion, however, the average modern radial drill is not built strongly enough to withstand the heavy work which can be secured from a high-grade, high-speed drill if it is pushed to the limit. Better results will be obtained by the construction of a heavy drill press, with stationary overhanging arm, the work to be moved upon a double-acting table having two movements, one at right angles to the other.

Rapid drilling in a shop is very necessary. It is, of course, important from the standpoint of economy in drilling, but the main feature to be considered is the fact that when work is sent to the drills, nine times out of ten it is then in steady progress of manufacture throughout the shop and under ordinary conditions, some one group of workmen will be found waiting for the drilling operations to be finished. This waiting may not be at all apparent, for the workmen themselves are very careful to conceal any such fact; but undoubtedly much time is lost in the average shop because of lack of high speed in the drilling operations.

Whatever device is adopted for the handling of work, very careful observation should be taken in order to determine the actual time lost in this manner. In punch-press work this handling time becomes even more important, inasmuch as in innumerable cases there are a number of holes to be punched in one plate or strip of metal. A very close study can profitably be made of the proper types of movable tables with indexes and positive stops. In fact, with a carefully designed series of stops for the different classes of work, a great deal of time ordinarily consumed in laying off the holes for punching can be saved. The use of such devices also insures greater accuracy in the punching. Ordinarily, the work of the punch-press operator is not as accurate as it should be, especially on heavy work. Where this inaccuracy exists, it causes an immense amount of trouble throughout the shop.

In the turning out of small parts, the question of handling time becomes of paramount importance. The amount of time consumed, for instance, in placing small work in a drilling jig, clamping the jig, handling the jig, and taking work out, will often be two or even three times the time required to do the actual machining operation. Therefore a close study should be made, first, of the character of these special tools, with a view to reducing to a minimum the handling time of the work and to replacing any tools which require an excessive amount of such time. Granting that the tools are all that they should be, a study of the time that should be taken by an expert workman then becomes important. This can be settled by stop-watch observations and by tests. All data covering such points should be recorded immediately.

Time Required for Machining Operations.—This time can be determined from the tables herewith presented, by the Committee and the tester together with the foremen and assistant foremen of the departments interested. Then this determination of time should be checked up upon each piece representing each classification by actually trying out the job as an object lesson, if for no other reason. Later, the proper machining time for the parts under each classification can be determined from the tables themselves.

My reason for strongly recommending Committee action in conjunction with the foremen will be discussed later, but a moment's thought at this point will show that this line of procedure will force the obstinate recalcitrant foreman into line in a hurry. He *must* give his support to the line of action. He is helpless as far as opposition is concerned. Furthermore, an improvement in the several departments under each foreman's supervision will become evident almost immediately. I consider this joint Committee action as absolutely necessary to the success of the plan. Always keep in mind that a speed boss or tester will be in a position to *prove* that work can be done within the specified time. Keep in mind however that it is always necessary to correct promptly any errors that may occur and that the workmen can demonstrate do exist.

Time Required to Remove Work from Machine Tools.—If the problem of handling the work originally is properly solved, the further problem of determining the proper time to be taken in removing work will be solved. The same problems of simple and effective clamps and efficient methods of hoisting and lowering work appear here. It is, however, necessary to emphasize the necessity for piling the work on the floor or on platforms in such a manner that it can be easily handled by the moving trucks. In the handling of light work it will often pay to give considerable attention to the problem how best to put the work into the boxes so as to facilitate its handling, to protect it from being marred, to facilitate inspection, and to make it easy for the next operator to handle it promptly. The relative importance of these different operations, however, varies very greatly according to the character of the work. What may be the most important feature of one class of work becomes almost a non-essential in another class.

EFFICIENCY IN THE BURNING OF FUEL UNDER THE STEAM BOILER.

By William D. Ennis.

II. THE REGULATION AND CONTROL OF FURNACE DRAFT.

One of the very significant things in the field of mechanical engineering just now is the wide-spread and eager movement in search of better economy in the boiler room. As Mr. Bolton put it in his series on superheated steam which was concluded in our May issue: "If steam is to retain its place as a method of power development, its whole cycle of operations must come under the definite and concentrated treatment which has been accorded in the past mainly to one end of the operation, viz., the steam-cylinder part of the combination."

Mr. Ennis's discussion which begins in our June issue is therefore as timely as it is thorough. He starts on the solid ground of fact and physical law, and makes perfectly clear what conditions are necessary to the economical burning of coal under the boiler, and what steps should be taken to discover whether these conditions are secured in any given plant, or if not, what remedies should be applied. His articles, which will be continued, will prove of great value to the careful and progressive power-plant manager or owner. The first part discussed the necessities of perfect combustion, and explained the bearings of flue-gas analysis. The section in this issue deals specially with the measurement and control of draft. Next month's installment will discuss the modifications in practical management necessitated by various commercial fuels.—The Editors.

THE reduction of excess air supply, which is the usual direction of improvement in boiler-room practice consequent upon closer study of flue-gas composition, is for practical purposes largely accomplished by a cutting-down of draft. It should be remembered, however, that force of draft and quantity of air supplied are not necessarily interdependent. The hypotheses of Peclet and Rankine recognize that in order to burn coal, the draft pressure must be sufficient to overcome the resistance offered by the coal bed to the passage of air through it. Beds of various kinds of coal offer different resistances to the passage of air; finely divided "slack" or refuse anthracite would seem likely to furnish higher resistance than "lump," "nut" or the graded sizes of anthracite. In practice, it is found that greater draft is required to burn fine anthracite than to burn slack, and greater draft to burn the graded sizes of anthracite than to burn even soft coal, which would certainly impose greater resistance to the passage of air through the fuel bed. It would seem as if a certain intensity of draft were required to break into the texture of the individual particles of coal, this intensity being necessarily greater in the case of hard, tough anthracite than with the more friable soft coals.

The quantity of air required for combustion differs, of course, in accordance with the chemical constitution of the fuel, as indicated below:

Fuel.	Wood.	Oil.	Soft Coal.	Anthracite.	Pure Carbon.
Composition by Weight: C........	53	85	73	92	100
“ “ “ H........	5	11	6	4	...
“ “ “ O........	42	4	21	4	...
Additional O required for C........	99	223	174	241	267
O required for H..................	40	88	48	32	...
N supplied with O..................	465	1040	744	914	893
Total air supplied..............	704	1351	966	1287	1160

These figures show that nearly twice the air supply is required to consume anthracite that is needed for wood, soft coal requiring about 17 per cent less air than anthracite. These differences certainly do not correspond to the differences in draft required to burn the various fuels. Wood can be burned with one-fourth the draft necessary for anthracite; while the draft necessary for soft coal is certainly not 87 per cent of that necessary for athracite, and oil fuel, although requiring theoretically the maximum amount of air, can be burned with very little draft, so long as the oil particles are finely divided by the atomizing burner. Draft intensity and volume of air supply are therefore not synonymous, although it is usual to control air supply within the limits imposed by the requirements of draft.

That this distinction is ordinarily not recognized is evident from the fact that many engineers who have given special attention to the matter of air supply, have formulated recommendations for economical operation based on an assumed most efficient draft intensity. Thus, in one large plant, it was found that the highest percentage of dioxide, and highest economy, were found with a draft slightly less than 0.2 inch of water. This was with semi-bituminous coal, fired with Roney stokers. Very slight departures from this amount of draft entailed heavy losses in evaporative performance. But it should be remembered that the result as stated is correct only for the specific coal under consideration, as actually fired. For another month's or year's run of coal, or for precisely the same coal, if there were any possible way of duplicating it, hand-fired or fired with some other form of stoker, it would have been found that the best amount of air supply was to be secured at some other draft intensity; perhaps not widely different from 0.2 inch, but still different.

Fortunately, it is possible to obtain, to some extent, independent regulation of the two factors under consideration. After once having ascertained that draft which is best suited to the physical nature of the coal, we may so control the air supply as to make it most appropriate for the chemical constitution thereof. There is some difference in the formulæ expressing the relation between air velocity and pressure; but if we take as conservative, $P = .0035\ V^2$, in which P is pressure in pounds per square foot and V, velocity in miles per hour, we have for pressure in inches of water and velocity in feet per hour, $p = V^2 \div 48{,}000{,}000{,}000$. Now, if we assume 40 per cent excess air to be the minimum under present conditions, for each pound of coal burned, 16.2 pounds of air must be supplied. Assuming the temperature of the atmosphere to be 60 degrees, the volume of one pound of air is 13.1 cubic feet. The product of 13.1 by 16.2, or 212, gives the cubic feet of air to be supplied per pound of coal. If v represents the velocity of this air in feet per hour, then for every pound of coal burned per hour an area for air passage of $212 \div v$ square feet must be provided. As $v = \sqrt{48{,}000{,}000{,}000\ p}$, the area for air passage, per pound of coal consumed per hour, must be $212 \div 219{,}000\sqrt{p} = .00097 \div \sqrt{p}.$ For an average small boiler burning, say, 900 pounds of coal per hour, the necessary air-passage area on this basis would be

$$\frac{.873}{\sqrt{p}}$$

say, for $p = .25$, $= 1.746$ square feet.

This gives areas which are certainly as large as, or larger than, those actually found necessary in practice. Thus, a recent writer reported, with .25 inch of draft at the damper, 900 pounds of low grade soft coal burned per hour with 1.32 square feet of air opening at the ash-pit doors; 14 per cent of dioxide being obtained just after firing and 9 per cent just before firing. These percentages of dioxide correspond to air supplies respectively 135 per cent and 189 per cent of the theoretical; the air volumes being respectively 184,000 cubic feet and 259,000 cubic feet per hour for pure carbon, or for soft coal containing 27 per cent of ash, 111,000 cubic feet and 156,000 cubic feet. For an ash-door opening of 1.32 square feet, the velocities necessary for the passage of these amounts of air are 84,000 and 118,000 feet per minute: whence we have

$$p = v^2 \div 48{,}000{,}000{,}000$$
$$= 0.146 \text{ inch and } 0.296 \text{ inch.}$$

The chimney draft at the damper being only 0.25 inch, that at the ash pit, under any condition of the fire, must be less than .25 inch. If we should make $p = 0.08$ inch and 0.16 inch respectively, as corresponding with 0.25 inch draft at damper for the specified conditions of fire, we would have for the necessary door openings 1.79 and 1.78 square feet in the two cases; so that the regulation of ash-pit door opening in accordance with the figures given is sure to give an ample supply of air.

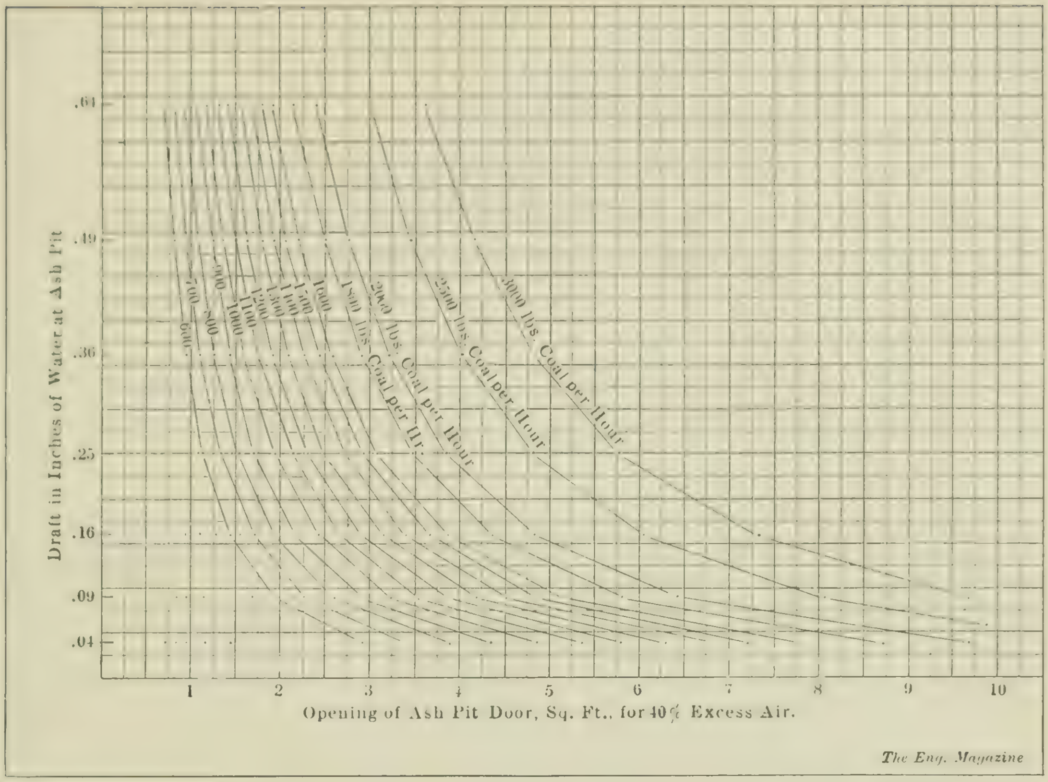
TABLE 4. AIR SUPPLY FOR VARIOUS DRAFT INTENSITIES.

	Draft at Ash Pit in Inches of Water.						
	.04	.09	.16	.25	.36	.49	.64
	Opening of Ash Pit Doors, in Square Feet.						
Necessary opening for 40 per cent. excess air, per pound of coal burned per hour......	.00485	.00323	.00243	.00194	.00162	.00139	.00121
Coal per hour, pounds:							
600	2.91	1.94	1.46	1.16	.97	.84	.73
700	3.39	2.26	1.70	1.36	1.13	.97	.85
800	3.88	2.58	1.94	1.55	1.29	1.11	.97
900	4.36	2.91	2.19	1.74	1.46	1.25	1.09
1000	4.85	3.23	2.43	1.94	1.62	1.39	1.21
1100	5.32	3.55	2.67	2.13	1.78	1.53	1.33
1200	5.81	3.87	2.91	2.32	1.94	1.67	1.45
1300	6.30	4.20	3.16	2.51	2.10	1.81	1.58
1400	6.79	4.52	3.40	2.71	2.26	1.95	1.70
1500	7.28	4.84	3.67	2.91	2.43	2.09	1.82
1600	7.77	5.16	3.89	3.10	2.59	2.22	1.94
1800	8.72	5.80	4.37	3.49	2.91	2.50	2.18
2000	9.70	6.45	4.85	3.87	3.24	2.79	2.42
2500	12.1	8.09	6.06	4.84	4.05	3.48	3.03
3000	14.6	9.70	7.29	5.81	4.85	4.17	3.63

Computations by 10-inch slide rule.

Accepting the formula for air-passage area, area $= .00097 \div \sqrt{p}$, the figures of Table 4 are presented, showing the necessary air-passage areas for various intensities of draft, and amounts of carbon burned per hour. These figures as expressed on Chart 3 may be used for anthracite coal; for soft coal, the openings might theoretically be reduced 17 per cent, were it not for considerations of gas mixture. They show, at least, what is gradually becoming evident, that a very slight amount of opening of ash-pit doors is all that is necessary for reasonable rates of combustion; and that such slight opening is indispensable if the economy is to be high. The formula and curve given may be disputed; in fact, the relation $P = .0035 V^2$ cannot be said to have been definitely established; but it certainly cannot be disputed that the vast majority of power plants are wasting coal because of ash-pit doors too widely opened.

Nothing has been said regarding the damper. The position of the damper may perhaps not be fixed so entirely from considerations of air supply, as that of the ash-pit door. For one thing, it is more



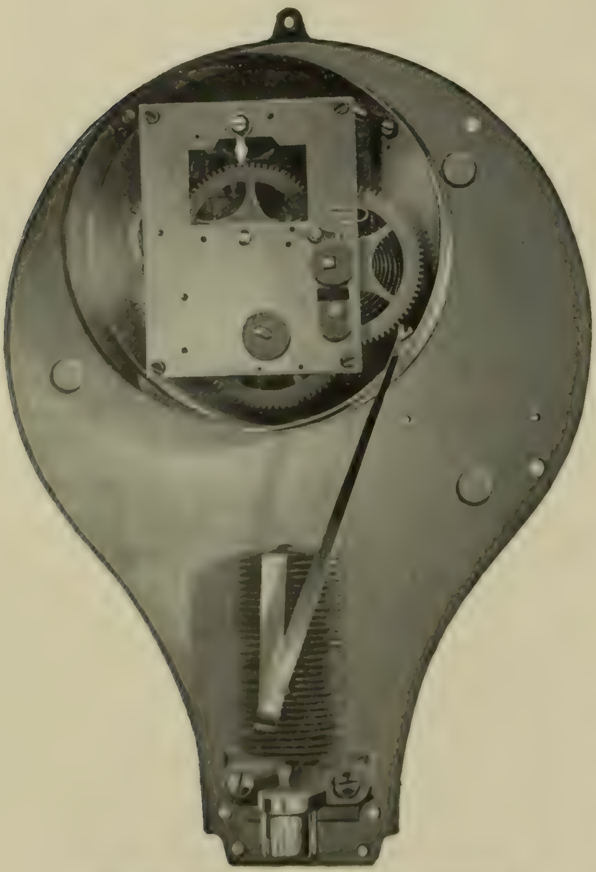
The Eng. Magazine

CHART III. RELATION OF AIR OPENING TO INTENSITY OF DRAFT.

difficult to reach and control. If this article shall in any measure have served its purpose, it will most assuredly impress on any power producer the absolute necessity of damper control. The damper should be made as easy and quick to operate and as simple, strong, and durable, as the best engineering design can accomplish. What would we think of a steamship in which the steering gear was located, say, on top of the deck house, accessible only by means of a ladder, sometimes found rusted fast, or covered so that movement was impossible? But the damper constitutes the steering gear of the power plant and is worthy of as important a place and of as much appropriate refinement of construction and operation. At this point we take the first step in the power problem of the day—the checking of draft so as to reduce the excess of air supply.

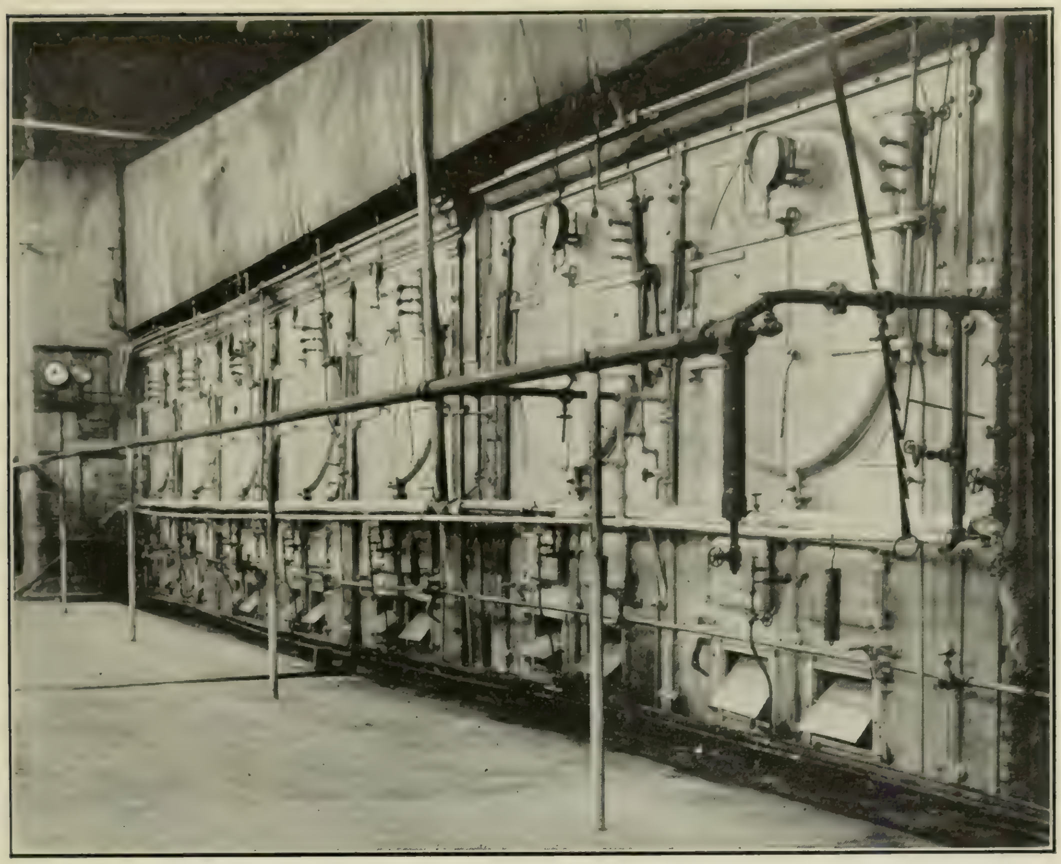
This does not necessarily point toward damper regulators. In theory, it would necessarily lead to choice of hand regulation. Our object in the boiler room is steam production, not a certain predetermined pressure of steam; that is incidental, or at most an indication that steam production is keeping pace with consumption. Our actual object is to evaporate. Under fixed conditions of design, the production of steam depends upon the rate of feeding the coal, the amount of air supplied, and the condition of the fire. The damper regulator controls but one of these three essential elements, and its control is effective only in consequence of variation in steam pressure, which is not always necessarily due to a variation in steam production requiring correction. We have already referred to the greatly decreased furnace temperature resulting from an excess of air. Suppose that a battery of boilers is under steam and under automatic damper control, and that the pressure begins to fall. The regulator immediately admits more air, which, unless a sufficient amount of coal is at once supplied, will chill the furnace and decrease steam production. The condition of the fire in some of the furnaces may be such that this sudden supply of fuel and air may not be detrimental; but in other of the furnaces it may result in waste.

All progress, however, must be along lines of least resistance; and since the problem of furnace operation is to compel attention to, and control of, the dampers, any mechanical device which simplifies that problem is a benefit. No mechanical device can possibly produce the perfect results that would follow the constant application of human intelligence; but no class of labor has ever yet duplicated the regularity and thoroughness of a machine. Perfect hand-control of dampers would be the best thing, but is impossible of achievement; the next best thing is to supplant hand regulation, so far as is possible, by automatic control. In the case of damper regulators applied to a battery of boilers, this partial control must be supplemented by the exercise of skill and judgment in order that detrimental results may be avoided.



BRISTOL RECORDING DRAFT GAUGE.

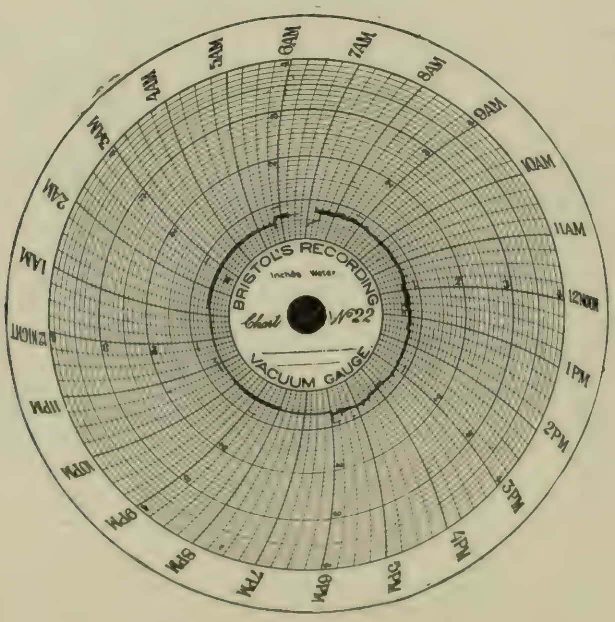
For pressures below 4 lb. a still more sensitive form is made reading between 0 and 2 lb. A tube from the nipple at the bottom leads to the chimney or flue, the recording instrument being placed anywhere, at convenience.
The Bristol Co., N. Y.



AN OIL-BURNING BOILER PLANT WITH SENSITIVE DAMPER CONTROL.

In this plant, under Mr. Ennis's management, a battery of old horizontal boilers were worked up to an efficiency of 83 per cent, while driven 30 to 50 per cent beyond their rating. The sensitive dampers on the ash pits were "home-made." They were unusually wide open when the picture was taken.

Ideal control would be that which would maintain uniform condition of fires in all the boilers of the battery; an adjustment of the rate of coal feeding, and a corresponding adjustment of air supply. These requirements would appear necessarily to involve some form of mechanical stoker; and the best results in power production on a large scale are no doubt secured where stokers are employed with the highest class of skilled attendance and supervision. Those forms of stoker which are driven by independent steam engines or motors lend themselves readily to regulation of feed. Stokers should not be started and stopped so as to produce intermittent combustion averaging so as to correspond with the load requirement; but the speed of feed should be nicely adjusted in accordance with the variations in requirements for steam. The hand regulation of the dampers should be facilitated by making the control levers easy of access and of operation, with plainly cut notches to determine and indicate the amount of opening, and an accurate draft gauge located in a conspicuous position where its reading will be evident at a glance. The time may come when it will be possible to replace the draft gauge by a direct measurement of air supply, so that the rate of feeding both fuel and air may be indicated at each moment. With such devices, and a cheap, portable form of carbon-dioxide indicator, all located immediately over the front furnace doors, it would seem as if a very close approach should be made to ideal combustion.



RECORD MADE WITH A RECORDING DRAFT GAUGE.

Bristol recording gauge, at the power plant of the B. F. Goodrich Co., Akron, Ohio. Natural draft.

It is the practice in very large steam plants to maintain a number of reserve boilers over banked fires at all times. This is to minimize risks from breakdown which would throw boilers out of service, and also to take care of variations in load. At first sight it would seem as if such a mode of operation were necessarily highly wasteful of fuel. As a matter of fact, however, it is found that even the large stand-by losses consequent upon this practice are less than those involved in forcing the boilers with intensified draft to a point where the air supply becomes excessive beyond comparatively low limits. This furnishes an extreme illustration of the wastefulness of operation when an excess of air is permitted.

THE INTERCHANGE OF HEAT IN STEAM-ENGINE CYLINDERS.

By W. F. Cleveland.

THE theory of the interchange of heat between the working steam at its varying degrees of pressure, humidity, and temperature, and the internal surfaces of the cylinder walls and pistons, has been the subject of much controversial discussion; but its corollary of condensation losses, however fallaciously deduced, is generally accepted as the method by which these losses—the most serious of all in the application of steam power—are sustained. It seems strange, however, that the theory has not been subjected to more rigorous adverse criticism, as there are abundant facts relating to the action of heat under other but analogous conditions which cannot be harmonized therewith, and when properly submitted as evidence are simply overwhelming in the conclusion to which they point—that the theory as applied is a false one, or true only to an insignificant extent as the basis of trifling losses.

Objections to the theory have been raised on the ground of the inadequacy of the time afforded during a fraction of the piston stroke, when passing the point of release, where the losses are said to be chiefly incurred; but in presenting this argument a proper association of the facts relating to the action of the heat under common and familiar conditions seems to have been neglected. At three hundred revolutions per minute, or for locomotive engines with six-foot drivers a speed of a trifle over sixty miles per hour, the entire stroke of the piston is covered in one-tenth part of a second, but during the first and a portion of the second quarters, according to the location of the cut-off, the absorption of heat by the metal surfaces from the entering steam must first take place; and as there is little space for expansion earlier than the point of half stroke, the out-flow of heat must necessarily occur during the latter half-stroke, or at most in one-twentieth part of a second. If, as is claimed, the losses occur chiefly when passing the point of release, the time must be still further reduced to perhaps the fiftieth part of a second.

If, in this discussion, we were concerned with electric instead of thermal currents, the importance or bearing of the element of time could not be so intelligibly considered. A naked finger may with impunity be quite slowly passed through a gas flame, but no sane experimentalist would approach a "live wire" with a similar intention. The flesh of the human body is a good conductor of heat, and the temperature of a gas flame is many times greater than that of steam, as used in locomotive boilers; but the significance of these facts may be still further emphasized by varying the experiment by the use of a common friction match or strips of paper, which may be slowly passed through the flame without ignition. The sensation occasioned by a single passage of a finger through the flame is very slight, but although the surrounding atmosphere has the cooling effect of air currents afforded by the alternate passage of the finger through it, there is a gradual accumulation of heat which becomes unbearable at the nail after about thirty-five passages. Matches and small rolls of paper ignite in about the same time. These facts cannot be harmonized with a theory based on the assumption of the rapid flow of heat currents.

In a standard locomotive cylinder using 180 pounds initial pressure, there is a range of temperature, between admission and exhaust of about 139 degrees, the falling temperature accompanying the pressure, at the point of cut-off, in its gradual descent throughout the expansion curve, but dropping suddenly in unison at the point of release, where the heat stored in the surfaces of the cylinder walls and piston is said to be suddenly transferred in the minute fraction of a second to the escaping steam, and lost in the exhaust. The figures given represent the difference between the steam-chest and the average exhaust temperatures, but without the use of some auxiliary valve attachment, for separating the initial from the final exhaust (an experimental device of extremely difficult application) the lowest cylinder temperatures cannot be recorded by the use of thermometers. Under the assumption that extremely variable and constant pressures are governed by a constant ratio of temperature, the steam indicator may afford the desired information. It is therefore assumed that a rapid outflow of heat takes place, similar to that occasioned by the sudden plunging of red-hot metal into cold water; but everyone is familiar with the fact that heat will not flow so rapidly, even in such an experiment, as small strips of heated metal may be suddenly immersed and withdrawn, say in one-quarter of a second of time, with but little change of temperature. The prolonged sizzling of small pieces of heated metal when thrown into cold water affords additional evidence of the moderate flow of heat currents, even when induced by a great range of temperature, and a heat-absorbing agent of enormous capacity. Simple experiments in physics with which every school boy is familiar, like the illustration of the flow of heat through metal rods, by the dropping of balls of wax, adhesively suspended at successive intervals from the point of heat contact, have imparted lessons which seem to have been utterly ignored in the application of this theory.

A law of heat on which the economy of steam boilers is based permits the flow of heat from iron to water, or aqueous vapor, much more readily than the reversal of the current, and imposes another difficulty in the way of the acceptance of this theory. If it were an equally reversible law, the losses by radiation from steam boilers would be far more serious. The enormous temperatures of the furnace and fire tubes force the heat into the iron sheets, from which it much more readily flows into the water; but the resistance to a reversal of the current at the outer shell of the boiler is an important factor in the maintainance of its efficiency. Heat will flow from iron much more readily than it will flow into it, a fact that may be verified (in connection with the previously cited experiments) by the sudden immersion and withdrawal of thin strips of cold metal from a pot of molten iron, when the change of temperature will be found almost imperceptible. Such strips of metal are but slowly fusible, when thrown into the molten iron.

If the metal surfaces of the internal parts of the cylinder are robbed of their heat during the period of initial exhaust, their restorage must take place during admission, and the time is therefore almost equally limited; but if the flow of thermal currents into metal surfaces is so slow under analogous conditions, and with such enormous ranges of temperature, the conclusion is inevitable that the internal surfaces of the cylinder parts, already raised to the temperature of boiling water, cannot absorb from steam at a fraction of the temperature of molten iron, or communicate thereto, a much greater volume of heat in a fraction of the time.

In order to avoid the branding of the theory as self-evidently absurd, it must be contended that only a very thin shell of the internal surfaces, say to the extent of five or ten pounds of iron, is thus subjected to changes of temperature; but under this assumption another difficulty is encountered in the limited volume of heat units that could be absorbed and discharged within the claimed fraction of the total range of temperature of 139 degrees. At the average speeds of modern locomotive engines, there are no scientific instruments capable of determining, with any degree of reliability, what this fraction may be; but it is certain that it is infinitesimal. The indications of such instruments, in tests that have been attempted, were undoubtedly occasioned by the variations in the temperature of the working steam itself. Such changes of temperature in the metal surfaces, moreover, although we may suppose them to be extremely thin, would induce serious expansion and contraction, and in a short time result in crystallization and crumbling of the parts exposed to their action.

The galvanometer as applied by M. Armand Duchesne, of the University of Liège, in recent experiments, is an instrument actuated by thermo-electric impulse. That actual heat absorption and discharge to any appreciable extent, by the silver and platinum couples of the instrument, is necessary for the production of such impulses, cannot be demonstrated. If such absorption and discharge were the only principle involved, nothing short of complete action throughout the full range of temperature would insure an accurate record. There is evidently some subtle molecular action occasioned in the couples by the changes in the temperature in the working steam, the character of which is as little known as the real nature of electricity. When, therefore, the distinguished experimentalist placed his couples within one millimetre of the internal cylinder surface, he simply interposed an additional resistance, not taken into account in the preliminary calibration or graduation of the instrument, which satisfactorily explains the reduction in the recorded temperatures. The couples themselves, as placed in the clearance spaces, were subjected to precisely the same thermal action as the cylinder walls, and if the record they conveyed had been one of heat changes in the couples, instead of heat changes in the working steam, it would also have been true of the temperature changes in the cylinder walls, except for the allowance that should be made for the inferior conductivity of cast iron.

In these experiments it was found that, near the close of compression, the thin film of steam between the cylinder and piston heads, in spite of the unfavorable length of the time of exposure to heat absorption by the proportionately large enclosing surfaces, still attained a point about 145 degrees higher than initial temperature. And yet it is contended that the serious losses of initial condensation are occasioned through heat absorption by these same metal surfaces. Why should the greater weight of admission steam communicate a greater volume of heat when its temperature is so much lower? Of course there is a slight increase of surface, due to the movement of the piston, but inadequate as such an explanation would be, it is the only one apparent but it is not advanced, although the contention embodies an evident contradiction, with changes of temperature in the metal surfaces, as the basis of the theory. If such heat absorption by the metal surfaces were a possibility, the filling of the clearance spaces by compression with anything but water would be an impossibility. Superheating of saturated steam in such a confined space as the clearances of a steam-engine cylinder, without a corresponding rise of pressure, indicates a concentration, chiefly, of latent heat, and affords additional evidence of the baleful character of the products of compression, in the standard cylinder.

The superior economy of four-valved engines has been largely attributed to the alleged losses occasioned in single-valved engines by the passage of the exhaust through the live-steam channels, and to absorption thereby of heat from their surfaces, although the high revolutionary speeds of the latter class of engines, if the theory is to be logically considered, should afford a much more efficient protection from such losses, in their more restricted time of exposure to exhaust temperatures. If the theory were a sound one, the economic performances of these engines should be reversed, unless it should also be contended that the losses sustained by the cooling of the passages exceed those incurred by the cooling of the cylinder and piston surfaces. The admission passages in both types are filled, during exhaust, with the same material that is being discharged from the cylinder; but in four-valved engines the outlet is at the bottom of the cylinder, permitting the water of condensation to be blown therefrom with the aid of its own gravity. This seems a more reasonable explanation of the gain in economy than that afforded by the passage-cooling theory, which is advanced as a deduction from the interchange-of-heat theory.

It is contended that the water of condensation and vapor in the working steam flashes into true steam with the sudden reduction in pressure at the point of release, the implication being that with the corresponding drop in temperature that ensues at the same instant, an out-flow of heat from the metal surfaces is induced thereby; but the fact that this very change transforms the absorbing agent from the strongest to the weakest of conductors, is not advanced as a factor in the argument. The boiling point of water, within certain limits, is dependent upon the pressure, but at the point of release the volume of heat units to be discharged cannot act upon the water of condensation, within the cylinder spaces, unless there is an instantaneous or free expansion instead of a prolonged discharge of the exhaust. The immediate effect of such re-evaporation would be the complete drying of the cylinder walls and spaces, but the standard cylinder is unable to free itself from the aqueous residue of the exhaust, which condenses upon its walls, filling the space before the piston, and is swept into the clearance spaces, where it is re-charged with heat from the entering steam, to be followed by the endless repetition of wasteful discharge at the point of release. That metal surfaces continually subjected to the action of water under such conditions, in the course of a few revolutions would reach and retain an average temperature, dominated by that of the water with which they are sprayed, partakes strongly of the character of a self-evident truth. It is the water of condensation, acting directly upon the entering steam, that is the real agent of these so-called interchange-of-heat losses, although, properly speaking, there is no interchange of heat; it is merely absorption during admission and discharge during exhaust. The enormous heat-absorbing capacity of aqueous vapor is well-known, but this baleful characteristic is aggravated, by the facility afforded for its action, in the thorough mixture of the products of compression with the entering steam.

In the standard cylinder, the measurable temperature of the internal surfaces never rises much above that of boiling water, and cannot do so until through the motive agent, either before or after admission, means are applied for keeping them dry, a fact that is being recognized in the progressive use of superheaters. In compound and multiple-expansion cylinders, heat absorption by the aqueous elements is largely avoided by the restriction of the ranges of temperature in the successive cylinders, but the advantages of the system are difficult of application to locomotives. The value of free or instantaneous expansion of the exhaust, previous to discharge, in cylinders designed for the purpose, has been little understood or appreciated, although the transformation that may be effected in the character of the working steam by its use has been clearly demonstrated in recent experiments, which will become better known in the future. The practical application of the principle will open a new and interesting field in steam engineering. Under the restricted conditions of locomotive-cylinder construction it is of especial value, as the demands upon the locomotive for greater power, especially in the propulsion of heavy trains at the excessive speeds of modern railway travel, cannot be satisfactorily met, even by balanced compounds, with their unwieldy complication of reciprocating parts.

HYDRO-ELECTRIC POWER VERSUS STEAM FOR INDUSTRIAL PLANTS.

By H. von Schon.

IV. THE ENGINEERING STUDY OF A WATER-POWER PROJECT.

With this article, Mr. von Schon brings to conclusion his series which began in THE ENGINEERING MAGAZINE for April last. The preceding parts have taken up consecutively the general comparison of hydro-electric and steam installations as to cost, efficiency and reliability; the commercial study of a water-power project; and the description of some typical stations of widely differing types, with a list of opportunities waiting development.—THE EDITORS.

IN a preceding article of this series, the hydro-electric power project was considered as a commercial enterprise. The important factors, by the careful consideration of which a reliable conclusion as to the paying qualities of the project can be reached, were pointed out, and it was found that the burden of supplying the necessary data on these points fall upon the engineer. As has been shown, the analysis of a hydro-electric power project involves principles of topographical, hydraulic, mechanical and electrical engineering and, for this reason, the projection, design and construction of hydro-electric power plants form a distinct engineering specialty. From the first step in the necessary investigations to the last, the topographical, hydraulic, mechanical and electrical elements of the problem are so intimately connected and interdependent that an incorrect judgment of the proper application of the principles of any one is likely to render the final conclusions more or less erroneous.

It is only rarely that conditions are such that the most satisfactory site and scheme of development can be determined by a merely cursory examination. It generally becomes necessary to study carefully a considerable reach of the water-course to determine the best location, and the selection of the latter depends largely on a correct understanding of topography of the river valley and of its geological character. Such knowledge could be gained by means of extensive surveys and borings but the time and cost involved in such operations are not generally available in original exploitation of this character. The information must be gleaned, rather, from a general reconnaissance during which the topography and geology become pictured, so to speak, upon a mind which is trained to estimate the influence of their characteristics on the project under consideration. The experienced observer will instinctively distinguish the advantageous from the objectionable features and by a process of elimination will readily recognize the best obtainable locations for the development site and the equally important storage reservoirs.

The location selected, the scheme of development has next to be determined, and this problem may be solved in any of three ways, by direct development, by short, or by distant diversion. The determination of the available flow must first be made and this involves besides a consideration of the topographical and geological features of the drainage area, an examination into the general climatic conditions of the region and the application of hydraulic principles. It is not always desirable to concentrate a fall exceeding 25 to 30 feet at one place, as the cost and weight of a dam increases very rapidly above that height, and the enlargement of the flowage area, consequent on the building of a high dam, may necessitate the purchase of costly lands. It is, therefore, worthy of study whether the available fall may not be more economically obtained by the diversion of part of the flow into a canal, when the flow is large, or into a flume or pipes when the flow is small. Consideration of the topographical and geological features of the region must decide this question: a convenient side hill or plateau may offer a suitable location for conduits and, with high heads, a pressure line is generally the solution; and occasionally a sharp bend, detour, or ox-bow, so-called, of the river channel offers an opportunity to carry a part of the flow across the intervening peninsula, through a tunnel in case the land rises too high for other diversion methods. The comparative costs of direct development at a dam and of development by diversion must be balanced, due weight being given in the consideration of the latter case, to the probable loss of head and the effect of evaporation, leakage and ice on the volume of flow in open conduits. The general development scheme determines the location of the power station.

The design of the works proper, so as to secure safety, permanency and high efficiency, with maximum economy in first cost, maintenance and operation, involves the application of many of the important principles of civil, hydraulic, and mechanical engineering. In alluvial locations, the planning of economical yet safe foundations and cut-offs will frequently tax the most experienced. The successful designing of works for the harnessing of the power of a stream can be accomplished only when accurate data as to the extreme conditions to be expected in flood time are to be had. The large majority of failures of dam structures are due to one cause, namely, the underestimating of the flood flow and neglect to provide adequate discharge section and cut-off safeguards. The solutions of these problems, do not lie on the surface but are revealed only to him who knows where and how to search for the truth and who possesses the ability and courage to form an opinion only on the merits of the case. Only too often the investigator permits himself to be influenced by enthusiasm, of his own creating or born of suggestion, which leads him to belittle difficulties and to exaggerate advantages. In such a frame of mind, even if competent, under ordinary circumstances, to form a correct estimate, he absolutely lacks the firmness to obey the dictates of his better judgment, because perchance this would render the project less desirable if not absolutely unfeasible. Some stern critics might call this downright dishonesty, but it is generally due to a lack of courage to stand by one's convictions or to inability to recognize the full extent of possibilities.

The designing of power equipment goes hand in hand with that of the works, as the design of the latter, at least that of the power station, is based upon equipment requirements. This calls for the application of mechanical and electrical knowledge. It is lamentably true that the extent of such designing very often consists only of reference to trade catalogues. If that is sufficient, the work does not require an engineer at all. Any manufacturer will probably honestly advise that such and such of his particular output is absolutely the best for the purpose and he certainly cannot be expected to urge the use of that of his competitor. The engineer herein referred to as competent to report on a hydro-electric project, designs the equipment himself, or, at least, he is competent to review the design of any turbine, governor, generator, exciter, or other machine, to determine whether it is capable of rendering the intended service.

It is the purpose of the foregoing to outline clearly the professional equipment which must be at the command of the engineer from whom may be expected a report of a hydro-electric project on which it will be entirely safe to base the commercial enterprise, to fix upon the capital investment, purchase lands, sell securities and close contracts for power service. No title nor degree nor association membership can guarantee such equipment in the man who affixes it to his name. Evidence of experience in this specialty, of reports rendered of plants designed and constructed under the responsible charge of the engineer, of a reputation for competency, and of absolute conservatism is the evidence to be looked for. There is a certain practice which, though calculated to lead to failure more frequently than not, is nevertheless rather general: that is, to secure a man to make a report on a contingent fee arrangement. I repeat that this practice generally leads to failure, because no such engineer as has been described can be engaged on such terms and when incompetency and unscrupulousness go into partnership the result can be readily foretold. As business men begin to realize more keenly the commercial value of every undeveloped water power, large or small, far or near, they will also find ways and means to remove their exploitation from the class of speculative enterprises. Supposing a company were organized for the business of insuring the works of a hydro-electric plant; it can hardly be said to represent a greater risk than a ship at sea; no policy would certainly be obtainable for a plant excepting upon the O. K. of a competent authority, and furthermore no hydro-electric project could be financed without such a policy being attached to the report. This is merely a thought, possibly original with the author, if so, it is offered for what it represents, but if this seed takes root anywhere I shall be glad to assist in nursing it to fruition.

In giving a necessarily very brief outline of hydro-electric engineering, the sole purpose is to present the essential features in the examination of hydro-electric projects and their correct treatment, in such a manner that the information may prove useful to the industrial promoter, the operator, and the investor, when applied as a rule by which the value of the conclusions, and thus of the commercial merit of the project, may be measured.

The functions of water power are flow and fall. The flow which is said to be available for development is properly called the "potential flow." All stream flow owes its origin to precipitation, except in extreme northern latitudes where rivers are still fed by glaciers. Of the falling rain, a portion is absorbed by vegetation and the remainder sinks into the ground. Only when the ground is saturated, or the fall is too great to be all taken up by the soil, does a portion remain on or flow off the surface. The disposition of snow, whenever it liquifies, is the same. The water absorbed by vegetation is converted into cellular fibre or is exhaled and vaporized, and vaporization carries off also a part of the water remaining on the surface or collected in lakes and swamps. The portion which enters the soil replenishes the great reservoir of ground storage, from which a constant supply is fed to vegetation and the remainder escapes to the stream valleys, in obedience to gravity, as rapidly as the permeability of the material through which it must pass, permits. The division of precipitation disposal among vegetation, ground-storage and surface run-off depends upon the topography, geology and climate of the drainage area, the latter comprising all the area finally contributing to the stream in question. The part absorbed by vegetation and vaporized makes up evaporation and the remainder is the run-off, the sum of the two making up the precipitation volume. The portion of precipitation chargeable to evaporation depends upon vegetation and climatic conditions, while the ratio of surface flow to run-off is fixed by the topography and character of the surface material.

A drainage basin which yields, in proportion to its area, the largest potential flow, is that in which evaporation and surface flow are a small portion of precipitation and the greater part of rainfall is absorbed by ground storage and regularly and constantly fed to the stream. Such a drainage area is characterized by a cover of deep drift of sand and permeable soil, and by a flat or light rolling surface with large swamp areas shaded by timber or brush. The opposite is an area of cultivated or grazing lands of hilly surface with rock at or near the top of the soil. In the former, only the excessively heavy rainfalls materially increase stream flow which is subject to only moderate fluctuations; in the latter, the stream rises rapidly with each rainfall, subsides with equal rapidity and continues to decrease in flow until the next rainfall. The river basins of northern Michigan, Wisconsin and Minnesota illustrate the former, and those of the Southern and Western rivers the latter. The stream systems of New England, New York and Pennsylvania rank between.

From extensive investigations of the amount of evaporation it is known that from 15 to 35 per cent of the annual precipitation remains available as run-off, and therefore the monthly run-off, were the total evenly distributed, cannot exceed one-twelfth of this, or from 1.25 to 3 per cent of the annual precipitation. Even this portion, as a matter of fact, cannot be accepted as the correct potential flow, which must be sought rather from the low than from the high monthly run-off. It is known that in northern latitudes on well controlled drainage basins, the low run-off for about 3 months, generally in the fall of the year, is from one-half to one-third of the theoretical mean monthly run-off, or 1.5 to 1.25 per cent of the annual precipitation. For eastern systems the value is from 1 to 0.75 per cent, for southern, from 0.25 to 0.12 per cent, and for western, from 0.16 to 0.1 per cent. Thus, with an annual rainfall of 40 inches,

the low monthly run-off of northern rivers is about 0.55 inch
" " " " " eastern " " " 0.3 "
" " " " " southern " " " 0.15 "
" " " " " western " " " 0.1 "

This represents the theoretical depth over the entire area, and this value may be translated into flow expressed in cubic feet per second per square mile of drainage area, by multiplying the depth of run-off expressed in inches and decimals by 2,323,200 (cubic feet on one square mile corresponding to one inch in depth) and dividing the product by 2,592,000 (seconds in one month). Thus the monthly run-off of 0.3 inch equals a continuous flow of 0.3 × 2,323,200 ÷ 2,592,000 or 0.27 cubic feet per second per square mile. If the drainage area contains 1,000 square miles, the low monthly flow under these conditions would be 270 cubic feet per second. If no storage reservoirs are available, from which this low monthly flow can be added to, this represents the continuous potential flow on which the development must be based unless the low flow output is to be raised by an auxiliary plant. Given the drainage area and the annual precipitation, an approximation of the potential flow, which will generally err on the safe side, can be readily obtained in this manner.

The closest determination of a stream's flow is secured by measurement of the various stages from low to high and compiling from the results a rating table which will show the flow corresponding to any stage. The measurements required for this purpose must extend over several years and are best made by gauging the overflow over a weir, or, if this is impracticable, the flow over a spillway with horizontal crest. Mill dams, if tight, afford fair opportunities for flow measurements by gauging the overflow daily and computing the flow, which equals, approximately

$$L \times 3.33\, h^{\frac{3}{2}}$$

L being the length of overfall in feet, and h the height of overfall in feet, the result being cubic feet of flow per second. When no such dams exist and the stream is too large to erect a measuring weir, the flow passing a fixed section must be measured. The section must be regular in shape and not subject to changes, and the measurements must cover the total range of the various stages of the river. Such measurements can be made with specially adapted instruments or with floats, but the use of any of them requires experience gained by practice, as indeed does the entire process of flow determination.

The possibilities of storing a part of the high flow for distribution during low stages must be thoroughly determined, as the desideratum lies in the utilization of the greatest portion of the annual flow. Tributaries emptying above the power site frequently present such opportunities, especially when they flow out of lakes. In this connection the evaporation from storage reservoirs must not be lost sight of, as during midsummer it will be as high as 5 or 6 inches per month.

When the monthly flow during a dry year has been found by any of these methods, it yet remains to be determined what is to be accepted as the basis of development, because the flow will probably vary from three cubic feet per second per square mile of drainage area during the spring, to one-tenth of a cubic foot or less during the fall or winter. As a rule, there are three months of well marked low flow, not always, however, in sequence; when one low month occurs between two higher, it is probable that the flow can be raised from storage, if any is available, to that of the other two. This may even be practicable with two or three low months in sequence, preceded and followed by a high month. The determination of available flow, or potential flow on which development is to be based, must be deduced from a consideration of all these possibilities. The character of the market demands may also enter into this discussion, as the loads in summer are smaller on the lighting and higher on traction service, than during the winter months. Finally, the applicability of a reserve auxiliary power plant must be considered and, if its installation is found to be advisable, the permissible output of such a plant must be fixed by comparison of the increased cost due to its operation with the price which can be obtained for the output. Thus, step by step, all these factors entering into the determination of the scope of development must receive due weight, in order to arrive at that decision which will represent the most economical, or rather remunerative, utilization of the available flow.

Much less intricate is the determination of available fall. The total fall in the stream over the reach to be controlled by the development is ascertained from levels, which should be returned to the starting point in order to insure against error. The concentration of this entire fall at one point or its diversion will depend upon the conditions pointing to the location of the development works, while the recommendable program will determine whether all or only a portion of it can be utilized.

When potential flow and fall have been settled upon the capacity of the development can be at once deduced by dividing the flow in cubic feet per second by 12½ and multiplying the quotient by the height of the useful fall in feet; in other words, each 12½ cubic feet per second of flow will yield one effective electrical horse power with each foot of the fall, in which rule turbines and generators are credited with practical working efficiencies. If the water is to be diverted in open channels or conduits a proper deduction must be made from the available fall for loss while thus diverted, as the flow of water is due to fall.

The mapping out of the development programme must be based upon all the foregoing conditions, the volume of flow, height of fall, the formation of river valley, bed and banks, character of sub-surface material, flood rise of stream, winter conditions, and the accessibility of works for the purpose of delivering construction material and equipment. The simplest arrangement consists of the concentration of all the fall at one point by closing the stream valley to the required height by a dam and placing the power station at one end or within the dam; or a portion of the fall may be thus accumulated by a dam and the flow diverted to a point lower down stream, the power house being placed at the terminal of such diversion. In cases of high falls, the dam may be placed at the uppermost end, merely acting as a diverting medium, while the water is taken through pipes or conduits to the foot of the fall. The diversion need not follow the river but can often find a much shorter route from head to foot of fall. It is readily conceivable that there are few occasions where conditions point at once infallibly to one of these programmes as the best. They must all be studied and compared and considerable planning and estimating are necessary in order to determine the best scheme of development.

The principal feature of a water-power plant is the dam. This is generally a composite structure consisting of a spillway, that portion over which the flow not utilized for development is to escape, and the dam proper which must rise above the greatest flood height. If the river banks are vertical rock walls rising above the height of the future upper level, then a spillway only is needed, but, as conditions are generally found, a portion of the valley also must be closed by a dam structure. The length of the spillway should be determined to pass the flood flow within a fixed height. This is computed from the discharge over weirs already referred to. In addition, other means of water escape must be provided, such as waste weirs or flumes, the latter being arranged near the base of the structure to permit of the lowering of the upper pool, so that the dam may be examined and repaired.

The choice of structural type should be guided by conditions of bed, volume of flood flow, availability of construction material, and height required. When the bed is of rock, the problem is greatly simplified, but when of alluvial formation it forms one of the most serious of the entire undertaking. Timber dams are not to be recommended on account of their perishableness, as the cost of maintaining them becomes a constantly growing charge, while the necessity of their renewal is a question only of time. Masonry dams are readily planned and constructed to guarantee safety and permanency but are the most expensive type, especially for alluvial locations. Concrete dams are equally safe and permanent but open to the same objection in soft river bottoms. Concrete-steel dams of the gravity type are the latest developed designs and combine safety, permanency and economy of first cost, while they are equally suitable for rock or soft locations. In rivers which are subject to high floods, the ideal type is a structure which affords the least obstruction to the passage of the flow, or which is in part movable, consisting of masonry or concrete piers, with gates or needles which can be readily operated. Concrete-steel gravity dams also largely fulfill this condition because of the opportunities to pass through them waste flumes, operated from the interior of the spillway. An arrangement should be provided on all dams by which the upper pool can be raised a few feet for the purpose of accumulation of flow during periods of non-operation.

The spillway terminates in abutments, to which is joined the reservoir dam. The latter structure may be of earth fill with masonry or concrete core wall, or of concrete-steel bulkheads. One of the most important structural features of spillway and dam lies in the absolute necessity of cutting off all underwash or scour, which, in alluvial river beds, can be accomplished only by penetration into impermeable material. This cut-off may be a sheet curtain of timber or steel piles, provided no boulders are imbedded in the material through which the piles are driven. If the former are present, no sheet pile construction will avail. The cut-off must be, in this case, a concrete wall.

Next to the dam comes the canal or conduit, if the program includes diversion. When the flow is small an open canal is not recommendable because of the impossibility of making it water-tight except by expensive construction, while the loss from evaporation and, in northern latitudes, from ice, will be an appreciable percentage of the total flow. Timber flumes, wooden-stave, steel or concrete pipes are available for this purpose, their use depending upon the volume to be diverted and the location which can be secured. When canals are planned they must conform in form and size of section and slope of bed to well established hydraulic principles. The slopes of the banks, when long, must be broken by berms to prevent destruction from rains and surface run-off, and permanency is best secured by paving these with stone. The flow in unprotected alluvial channels should not exceed three feet per second, as the transporting force due to a greater velocity will move sand and small gravel. The intake to a diversion canal or conduit should be arranged to control the inflow and exclude floatage. Timber flumes should not be larger than the size required to pass the normal flow, so that the complete saturation of all parts of the lining is insured and early decay prevented. They must be securely and firmly bedded on sills and compacted material to maintain rigidity of shape as originally constructed and to prevent opening of the joints; the top should be covered to protect against the sun and cold.

Pipe lines must be planned in accordance with hydraulic principles, proper allowance being made for losses at entry and by friction, not only that of the new pipe but the rapidly increasing friction as the pipe ages. Wooden-stave conduits constructed of redwood, when properly built and kept filled with water, have proven quite as durable as steel pipe, are less costly, and develop less friction. For high pressures, exceeding 200 feet, only steel pipes are available, and the thickness of their plates and details of sectional construction must be carefully designed to guarantee safety. Concrete-steel pipes have been employed of late for this purpose with varying success, but they are not safe under pressures exceeding 50 feet. Location, curvature and anchorage of pipe lines are all-important problems requiring careful design.

The power station is the final and most important part of the plant. Here the water is passed in some manner through the turbines and back into the stream. The power station is located at the terminal of the diversion or at the dam, and the design depends, as to general arrangement, upon height of available fall, while the output fixes the dimensions. Up to a certain limit of fall, about 35 feet, turbines are economically placed in open chambers into which the water enters directly from the upper pool. In this case turbines are said to be drowned and are mounted on draft chests. For higher heads turbines are housed in metal cases, the water being fed to them through pipes. For either plan the station building requires a substructure called the pit and a superstructure in which the turbines are placed. The arrangement of the electric generators depends upon the installation of the turbines in a horizontal or in a vertical position and the connection desired between each turbine and generator, which may be direct or by gears. The structure may be of masonry, concrete or concrete-steel. The foundation requires the same careful treatment as that of the dam, the substructure must be heavy, while the super-structure may be comparatively light. Every part of the station should be readily accessible, pit and turbine chamber so arranged that they can be unwatered, and ample space should be provided to handle conveniently equipment for the purpose of installation and repairs.

The power equipment can be determined only after the units of output have been chosen and the latter must be based upon market requirements and hydraulic conditions. Generally speaking the units should be as large as permissible in output and they should be uniform. Where the entire output goes to one market, the whole capacity may be divided among equal units of such characteristics of power and speed as are representative of the most economical standard apparatus. These power and speed characteristics are determined from the volume of water, head, turbine capacities, and speed and adaptability of generators. When the output is to be sent to more than one destination, the requirements of each enter into the question.

The reaction turbine meets the requirements of heads up to 80 feet, and beyond that point the impulse wheel or a type composed of elements of both forms of equipment. Low-speed turbines require large and costly generators if direct coupled, and if geared some losses are incurred. Whether the turbine unit is to consist of one or more wheels is to be decided by a comparison of the respective costs of the complete hydraulic and electric power unit and its housing necessary for each arrangement. After the question of power units is settled the character of the equipment can be determined, that is of the turbines and governors, generators and exciter units, switchboard panels and cable conduits, which items practically complete the generating plant.

The current is to be delivered at a distant point, and for this a transmission line is required. How far can you carry electric current and what will be the loss during transit, is a frequent question. The limit of distance and of loss is purely a question of cost; current is now being sent over continuous lines of 300 miles and longer. While there are many conditions to be considered, it may be taken as a general rule that there should be 100 horse power to be transmitted for each mile of line, and the loss in transit can, in this case, be kept below 10 per cent. This question of loss is to be solved mainly by a consideration of the cost of copper and the value of the delivered current.

At the terminal of the transmission line a substation must be provided to receive the current. When the output is sold in bulk, this substation completes the plant, but where it is to be distributed it may be necessary to transform it to lower voltage, and convert it into direct current since the transmission from generating plant to substation is of alternating current only.

The cost of the works and equipment, and therefore of the output, depends upon many conditions and these can be given proper consideration in the preparation of an estimate only by a person who is competent to analyze them fully and to appreciate the value of their influence. The estimate should quote the unit costs of material, operations, and equipment upon which they are based. In other words, costs should be given in detail for each part of the work instead of lump sums for dam, canal, power house and equipment.

The cost of the dam should contain the item of "control of flow" during construction, which may require diversion of the stream, coffer dam and pumping. Dam foundations should be detailed as to excavation, bearing and sheet piles, cut-off wall and concrete. Timber piles cost from 25 to 35 cents per linear foot driven; timber sheet piles from 35 to 50 cents per linear foot, and steel sheet piles from 80 cents to $1.50 per linear foot; excavation of soft material 25 cents and of rock from 75 cents to $1.00 per cubic yard; masonry in dam from $8.00 to $12.00 per cubic yard, concrete from $7.00 to $10.00, and concrete-steel from $8.00 to $15.00. Reinforcing steel costs from 3 to 4 cents per pound and structural steel erected from $80.00 to $100.00 per ton. Turbines cost from $5.00 to $10.00 per mechanical horse power and turbine governors from $300.00 to $500.00. Generators cost from $10.00 to $12.00, transformers from $4.00 to $6.00 per kilowatt, and exciters $20.00. Switchboard panels cost from $250.00 to $400.00 equipped. Poles for line, 35 feet long, cost from $2.00 to $3.00 set, and 65 feet long, from $18.00 to $22.00. Cross arms cost from 40 to 60 cents, and insulators 35 to 75 cents. Copper wire at present costs about 26 cents per pound. To the total estimate should be added 10 per cent for expenses of engineering and inspection and a like amount for incidentals. Having found the cost of output, the value of lands, right of way, franchises, etc., must be added, and the total amount will be the investment required.

When all these data are collected the commercial prospect of the enterprise can be determined by grouping the fixed charges of interest on capital investment, sinking fund, operation, maintenance, depreciation and taxes on one side and probable receipts from current sales on the other. The apparent surplus will tell the story.

Generally speaking, an investment of from $160.00 to $180.00 per horse power delivered will show a net earning capacity of 6 to 8 per cent. These are rather high cost figures. The large majority of hydro-electric developments range between $125.00 and $150.00 per horse power and are therefore capable of a commensurate increase in net returns. The value of these investments is, however, more likely to increase than otherwise, since every indication points to a rise in the price of power service in all branches of industry.

EDITORIAL COMMENT

THE new Catskill Mountain water system for enlarged supply to the city of New York is in many respects, and probably in net total, the most interesting work of engineering construction now under way—and since the ceremonial opening on June 20 it may with all technical propriety be said to be "under way." The stage of careful study and able planning and preparation gives place formally to the stage of physical construction.

The undertaking has not, perhaps, the avoirdupois of the Panama Canal, but it has finer, more complex and more original problems than those of the greater waterway. And it is peculiarly a product of civilization, the necessity which demands this huge enterprise—an outcome of the concentration of a swarming population within the confines of a limited city, to which the prime requisites of life must be supplied and distributed by draft upon the open spaces of country still uncovered. The acres of the mountain and the meadow must continue to supply food, water, and clothing to each individual, but to the dweller in towns they must be brought by an elaborate scheme of transportation, and no part of the whole system appeals quite so strongly to the imagination as that which makes the mountain stream run to the very inmost lodgings of the heated town. Nine hundred square miles of hill country, open to the sky, to gather the supply; a reservoir twelve square miles in area to store it; a hundred and fifty miles of huge aqueduct to bring it to the householders of one great city; a filter plant larger than any yet constructed to purify it—these are only a few elements in the scheme which has been worked out so swiftly and so harmoniously that most of the people were scarcely conscious of the preparations, though they contemplate measures which surpass all precedent in engineering achievement.

A marked characteristic of the dedication ceremonies was the sincerity, the apparent strength of serious purpose, the confidence, and the buoyant enthusiasm of all who took part. Whether among those who have guided, those who have designed, or those who are executing the work, or among the participants in and guests at the ceremonies, the same temper was everywhere. It was a fine demonstration of the spirit of public enterprise conceived and executed in honesty and ability. The difficult work of the officials responsible for the undertaking is mostly done, and well done. Much of the difficult work of the engineer also is finished. And if the execution of the plans brings work yet more difficult, the engineers who have so ably conceived and carried on the project so far will prove amply competent to every emergency.

* * *

IN contrast to this wise conservation of the stores Nature provides, a curious foil is provided by the reported project for reforestation of the Allegheny and Monongahela valleys and tributary watersheds. This indicates a belated, but now startled and thorough, awakening to the criminal folly with which the waste of timber resources has been conducted. The measure suggested is heroic in its proportions; one estimate puts the number of trees required to be set out at 20,000,000, and the waiting period before relief will be afforded at fifteen years. But the loss and damage of the annual flood at Pittsburg and the adjoining cities are enormous and intolerable. Even this huge undertaking seems desirable, if by reclothing the denuded hillsides, checking the rapidity of the spring thaws, replacing the equalizing sponge of vegetable mould and woodland growth, and retarding the run-off, the violent fluctuations in stream regimen can be modified and the lower valleys protected from sudden flood waves.

So vast an object lesson should not be lost on other regions, but yet history suggests only too clearly that economic lessons have seldom been learned through the experience of others. The forests of the Hudson watershed are going the way of those of the upper Ohio basin, but faster, under the stimulus of higher prices for lumber and new markets for by-products. The bark slasher has been followed by the lumberman, the lumberman by the tie cutter, and the tie cutter by the "acid" maker. And of them all this last is the worst, for he strips the ground of every stick, large or small, regardless of kind or species, and leaves a naked surface behind him from which the rains and the snow runnels wash all fertile soil, leaving a desolation for all time like that of the barrens upturned by the gold dredge. Hesitant as we are to discourage any industry, and especially to see invested capital impaired as to its earnings, we should regard it as a gain to the State and the Nation if denatured alcohol should drive wood alcohol from the market and destroy the incentive for the establishment or the continuance of the "acid factory." In regions which ought to be the wild parks and summer gardens of the thickly settled Eastern States, richly repaid by those who resort to them for health and fresh air, the acid factory is devouring everything by which the country was made beautiful, and leaving nothing by which agriculture can live.

One of the most deplorable symptoms is the indifference to the destruction of assets going on around them which is shown by the residents themselves—the very ones who by agreed sentiment and action might most surely secure reform and protection. The tree has no value to them beyond immediate conversion into lumber or cordwood. Fine young saplings, the future treasury of the nation, or splendid shade trees which an incoming resident population would value at hundreds of dollars for ornament, are felled for firewood, to save the insignificant trouble of selecting trees of less value; wide, hideous, glaring barrens are chopped along the highways to "dry up the road," by commissioners or path masters ignorant of the first principle of road making—drainage; too incompetent even to know that "cutting out" is not only wholly ineffective, but also more costly than ditching. It cannot be expected that they would see the economic evil of stripping whole valley sides of their fine young second growth for the passing profit of a dollar and a half a cord.

It cannot be expected either that owners who by selling, or manufacturers who by buying and stripping the land can make a few dollars an acre, will refrain out of consideration for posterity. The remedy must be found in regulation by the State. Little as we love government intervention, this seems to be a case in which it is desirable—more, necessary. The State alone can act with the requisite power and the proper broad and far-sighted regard for the interests of the citizens of today and of the years to come.

* * *

In the death of Sir Benjamin Baker the world loses one of the greatest masters of constructive engineering of our times. He had the breadth of vision which saw huge problems so clearly that they seemed simple, and a simplicity of soul which carried all his honors without self-consciousness. The world will remember him by the monumental memorials of his work—his friends, by his gentleness of heart.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

INSURANCE OF LABOUR IN GERMANY.

FEATURES OF THE ACCIDENT-COMPENSATION AND OLD-AGE PENSION SYSTEMS OF GERMANY.

Engineering.

IN the April number of THE ENGINEERING MAGAZINE, a review in these columns described certain features of the national system of labour insurance recently established in Italy. Under the Italian system, insurance is effected by the employers of labour in a national fund which is under the direct control of the State. In Germany also accident insurance is compulsory and it is, to a certain extent, regulated by the State; but in general the employers are responsible for the establishment of insurance funds and there is but little governmental interference. The following details of the German system are taken from a recent number of *Engineering.*

The legislation on which the present system is based was passed in 1900. This decree rendered accident insurance compulsory on the part of employers of labour and affects workmen in all classes of industry whose annual wages are 3000 marks (150*l.*) or under. It also covers domestic service and cases of accident which might occur to operatives away from their regular work when they are acting under their employers' orders.

"Although accident insurance is compulsory as aforesaid, and is carried out under State guarantee, the State, so to speak, stands apart, and, although controlling the insurance, does not overburden employers with red tape in the matter of all the minute insurance clauses. The employers of similar trades and crafts have joined together, and have formed district trade insurance associations in the central towns of the districts throughout the country. These are self-managed bodies, who appoint sub-committees and agents, and obtain full reports on each individual case which comes under their jurisdiction. For State work the trade associations are replaced by Government boards for the consideration of cases of accident.

"The law on accidents provides compensation for all cases except those in which the accident was caused by the victim intentionally, the compensation being paid after the first thirteen weeks, during which preliminary period the sufferer is on the sick-list, and receives medical treatment and a part of his wages. If the workman be rendered totally unfit for work as the result of an accident, he receives as a pension two-thirds of his annual wages. For partial disablement the compensation varies according to the consequences of the injuries received. In both cases the patient is given immediate surgical and medical treatment, this continuing as long as is necessary. If the accident causes the death of the workman, his funeral expenses—equal to a fifteenth part of his annual wages, minimum 50 marks (2*l.* 10*s.*)—are paid by the association, the latter further granting to his representatives an annual pension of from 20 to 60 per cent. of the annual wages of the deceased, this being distributed to the widowed consort, to the children under sixteen years of age, to indigent parents, grandparents, and to orphan grandchildren.

The above proportions of the wages, however, are not absolute, and it is within the discretion of the trade insurance associations to increase the pension to the full amount previously earned by the deceased; the same applies occasionally in the case of absolute permanent incapacity for work; while, when unemployment is traceable to the consequence of partial incapacity for work following an accident, the compensation may reach for a time two-thirds of the wages as paid to those who become totally unfit for work.

"The annual wages are taken, under the decree, at 300 times the daily wage. Under former enactments the maximum was 1200 marks (60*l.*); it is now 1500 marks (75*l.*), and all sums exceeding this product are counted, for pension and compensation purposes, at a third their amount.

"During the first thirteen weeks following an accident the operative is cared for by the sick fund, or at the employer's cost. Following this preliminary period, when the operative is being attended to, and his family is receiving aid through the provisions made by the sick fund, he may, subject to the decision of the trade insurance association, remain in the sick club, the said association taking over all medical charges and compensation allowances from the thirteenth week; or the association may take a case in hand from the moment the accident occurs, charging the sick fund with all expenses incurred during the first thirteen weeks.

"The amount of claim is settled without loss of time by the trade insurance association on the evidence of a report made out by the police; when the settlement is likely to be delayed by investigations, the injured workman is paid a sum on account. The time during which a claim for compensation for an injury traceable to an accident may be put forward is two years from the date of the accident. A workman who is not satisfied with the decision given in his case by a trade insurance association can appeal within a month to an arbitration court, formed of two representatives, one selected by each party, a Government official, acting as umpire. This court settles all minor and current disputes. More important decisions may be carried for appeal to the Imperial Insurance Bureau, the head authority which has charge of the labour decree, its operation and matters of jurisdiction connected with it. This consists of a president, appointed for life by the Emperor, and twelve temporary members, of which six are representatives of the Bundesrat (Federal Council), and six representatives of employers and operatives in equal numbers in industry, agriculture and transport. There are also other permanent members of administration appointed by the Emperor, twenty-one for accident insurance and six for disablement insurance; legal advisers, and Government delegates; all of whom form the different committees and courts of equity.

"The amount of contribution of each separate employer of labour towards his trade insurance association is in proportion to the risks which his membership entails upon the association. The risks for each separate establishment are determined on the basis of a danger tariff drawn up by the association, and in proportion to the total wages paid.

"An interesting feature in the decree is that the State does not interfere directly with the question of protective devices and appliances; it acknowledges that it is to the interest of the trade insurance associations to improve these, and always to put down the very best, and has left the decision and jurisdiction as to the selection of such appliances entirely in the hands of the associations. The latter have the power to increase the assessment of those members, being employers of labour, who do not adopt the most perfect appliances in the matter of safety. The associations have also framed rules with regard to safety, and may fine the operatives who transgress these rules. The question of safe working and safety appliances is, however, under the general supervision of technical inspectors appointed by the Imperial Insurance Bureau above referred to.

"The sick fund already alluded to is worked in conjunction with the provisions of the law on accidents. Insurance with the sick fund is compulsory, the workmen contributing two-thirds, and the employers one-third, both calculated in percentage on the wages, the workmen alone participating in the benefits of the fund. These benefits are: medical treatment or free hospital treatment, and sick-pay for thirteen weeks, the sick-pay being half the daily wage, as a minimum; this is increased in special cases. Should an accident prove fatal while a workman is being relieved by the sick fund, his representatives are allowed from the said fund funeral expenses amounting to twenty times the average daily wage. Insurance with the sick fund is compulsory on behalf of the employés and workmen whose annual wage does not exceed 2000 marks (100*l.*). Independent employés, and those whose wages exceed the said limit, are at liberty to insure or not. The sick fund is administered independently of the Government, and is divided into sections in the various districts throughout the country, the divisions covering each the same trade, or the callings in which risks are practically equal. Each section is independent of the other sections of the same district, and of similar sections of other districts. This greatly facilitates management, collection of contributions, and prompt distribution of relief; also the detection of cases of malingering, and the settlement of disputes. The latter are decided, free of cost, by the local courts of justice.

"Besides the sick funds which work in conjunction with the trade insurance associations, and whose awards in the matter of relief to really necessitous families are not infrequently in excess of the limits above stated, there are private sick funds, the membership of which is voluntary.

"In Germany insurance for securing an old-age pension, and for guarding against the effects of physical incapacity, was first governed by a law of 1891, which since has been superseded by that of July, 1899, which came into force in January, 1900. Insurance is compulsory on the part of all inhabitants on completing their sixteenth year, the law covering all employés, whatever be their trade, apprentices, domestic servants, engineers, foremen, clerks, shop assistants, teachers, ships' crews, &c., whose annual wages do not exceed 2000 marks (100*l.*). It is compulsory also on the part of small employers of labour who employ but one assistant workman. Insurance is voluntary on the part of employés whose annual wages are from 2000 to 3000 marks (100*l.* to 150*l.*). The following are exempted from compulsory insurance:—Officials in any way connected with Government, also public school teachers, while training for their profession, if they have expectations of a pension equal to the lowest incapacity and old-age pension; soldiers who during their service are employed as workmen; persons giving instruction for remuneration during their studies; infirm persons who are entitled to an incapacity pension, or whose capacity for work is reduced permanently to less than one-third; persons who, in exchange for their work, receive no wages, but board and lodging, or who can obtain only temporary employment.

"The personal contributions to the fund, if they have been regularly paid for a minimum period of 200 weeks, are reimbursed in cash on application; to the insured female who marries before she is of age to obtain an annuity; to the representatives of a deceased workman; and to operatives permanently disabled by reasons of an accident, and who obtain the accident pension.

"A pension for incapacity is granted to those persons who become unable to earn at least one-third their average wage, after they have contributed to the fund for at least 200 weeks, their altered circumstances being duly ascertained by official inquiries. The old-age pension is granted to all contributors on reaching their seventieth year, after they have contributed to the fund for at least 1200 weeks. To each annuity when it becomes due, whether for incapacity or by reason of old age, Government adds the amount of 50 marks (2*l.* 10*s.*). Government also pays the contributions to the fund of the men while accomplishing military service.

"For the purpose of establishing the amount of individual contributions to the incapacity and old-age pension fund, the wage-earners have been divided into five classes, according to the following total annual wages earned:—350 marks (17*l.* 10s.), 550 marks (27*l.* 10s.), 850 marks (42*l.* 10s.), 1150 marks (57*l.* 10s.), and above. Contribution to the fund, based on these totals, are paid each week, half by the operative and half by the employer. As a general rule, the employer pays the total sum and deducts half from the operative's weekly wage. At the present time, the total weekly contributions to the fund are as follow, as per the above classes:—14, 20, 24, 30, and 36 pf. (1.68d., 2.40d., 2.88d., 3.60d., and 4.32d.).

"With reference to the working of the incapacity fund in conjunction with the old-age pension, the main point to be borne in mind is that no man can enjoy any two pensions simultaneously. The two insurances are essentially one. If a workman, at whatever age, becomes incapable of work through sickness (during actual sickness he is provided for by the sick fund), and has accumulated at least 200 weeks' contributions, he had a title to an incapacity pension, as long as he remains incapable; even if, for the rest of his life, he will never enjoy an old-age pension."

THE EIGHT-HOUR DAY IN FRENCH GOVERNMENT WORKS.

THE EFFECT ON OUTPUT AND COST OF PRODUCTION OF THE INTRODUCTION OF THE EIGHT-HOUR DAY.

Engineering.

ATTEMPTS to shorten the hours of labor in all trades by legislative enactment form one of the principal features of socialistic and labor movements in all manufacturing countries. The chief argument of the advocates of such measures is that the short working day benefits workmen and employers alike: the laborers have increased opportunities for rest and recreation and the employers profit by the increased energy and zeal of their workmen. It is safe to say, however, that the establishment of eight hours as the legal working day has never failed to work incalculable injury to the industries affected. The experience of the French government works as described in a recent number of *Engineering,* is one of the strongest evidences of the pernicious effects of such legislative interference.

"The consequences of the measure in those French Government factories in which it has been applied are absolutely deplorable. Certain departments had foreseen this, and the directors had asked for higher grants, in order to meet the higher expenditure which the reduction in the working hours was likely to entail. The fact is further confirmed by the Labour Bureau—an annex of the Labour Ministry, whose tendencies are distinctly favourable to all Socialistic measures. This bureau has recently published a series of reports on the eight-hour and nine-hour days in State works and arsenals, reproducing those issued by the chiefs of the said establishments; the reports in question give expression to the bare fact that decrease in the number of working hours has led to a decrease in output, and an increase in outlay.

"The eight-hour day was introduced in the French naval arsenals in 1902, by a former Minister of Marine, who is held largely responsible for the present unsatisfactory state of the French Navy. Without awaiting the results of the measure, he extended it to all the arsenals from the commencement of 1903. He certified that the first results were most satisfactory. In 1899 the eight-hour day was tried at the postage-stamp works; at first, as might be expected, the men increased in zeal in order that the measure should not be repealed, and, so far as the actual cost of working can be arrived at in a Government factory, where there is no commercial organization, it was found that during the first three months conditions under the eight-hour *régime* were approximately equal to those under the former ten-hour *régime.* But the effort on the part of the men was not maintained; an official report states the fact that the output decreased. Moreover, the authorities had done away with piece-work to please the men, and very soon after an increase in wages had to be paid to obtain the same output as formerly. But this did not prevent the authorities from extending the 'reform,' which now applies to all the postal and telegraph craftsmen throughout the country. Another official report establishes the fact that for an equal amount paid in wages (the men have as much for eight hours as they had for ten) the output has decreased by one-tenth, and in some cases by two-tenths; and this, notwithstanding higher speed machines and a number of mechanical improvements. The men lay claim to producing 'better work,' because they have not to hurry as they did when on piece-work; but all persons who are able to visit the State factories know what to believe of this assertion. The authorities who have signed the official reports have concluded them by stating that 'it was hardly possible to expect better results.' And it is to such 'satisfactory' results that the Socialists appeal with a view to generalize the measure.

"In the National Printing Works the consequences have been similar. It was decided in 1905 to reduce the hours from 10 to 9 in the match and tobacco factories, the latter figure corresponding to eight effective working hours, and immediately afterwards it was necessary to open a supplementary credit of 2 million francs (80,000*l*) to meet the effects of the reduction. It has been officially recognised that the decrease in output would be exactly in proportion to the decrease in the working hours, and a proof of this is the circumstance that to enable the men employed on piece-work to earn as much as formerly, and without more labor, the basis price of their remuneration has been increased. The measure has led the State to incur heavy outlay in other directions; it has been necessary, among other things, to increase the shops and factories for taking on new hands in order that the available output should keep up with the demand. In the Mint the working day has been reduced also; the men would not consent to earn less—on the contrary, the wage per hour has been increased by 10 per cent. The men promised to produce as much in nine hours as in ten; this was the case for three months only, as in the above example, and the number of hands had to be increased afterwards.

"The most insignificant work in the naval arsenals costs fabulous prices. At the commencement of the 'reform' in these establishments the men showed zeal, but they soon slacked off, and found encouragement from the former Minister of Marine, who was then disorganizing the French Navy by conferring fresh favours; it is not astonishing, therefore, to find it reported that at Lorient Arsenal the cost of the output has increased by 15 per cent., following the decrease in the working hours. The Director of Cherbourg has stated that work did not exceed 7 hours 40 minutes; it had been reduced by 13 to 14 per cent., the reduction in output being no doubt proportional for the greater part of the *personnel*. He added also:

"'If it was hoped that the men, being less burdened with work, would compensate for the reduction in the working hours by good-will and eagerness for work, there has certainly been a mistake.' The eight-hour day became rapidly an accomplished fact, it was taken as a right, and the zeal of the early days completely disappeared. The most one notices is that there is, perhaps, less slacking off on the part of the men towards the end of the working day in the summer months. At Rochefort attempts have been made to tabulate the consequences of the 'reform' in the construction of torpedo-boats, and it has been found that the time for building these vessels has increased by 1.4 per cent. at least, and the cost by 7.5 per cent. The Ports authority who gave these figures has added in his report—and in this he is in contradiction with his colleagues in the other ports—that he has found an increase of activity on the part of the men, which he puts down at 14 per cent. One may ask in what manner he can reconcile this statement with the fact that work takes now more time, and is much more costly? Mr. Laubeuf, a well-known French naval architect, but who is not *persona grata* with the Naval Bureau, has stated, on the other hand, that the loss of output due to the measure is 19 per cent., and that the effective working-day now only amounts to 7 hours 10 minutes. He also had noticed at first an appearance of zeal on the part of the men, from which one might have hoped that, loyally worked to, the new measure would have given good results; but he was promptly disillusioned. At Toulon, in repair and maintenance work, the new *régime* entails a 24 per cent. increase in direct, and 33 per cent. in total expenditure. Here, as in the other arsenals, piece-work was done away with. The increase in expenditure of one-third at Toulon alone influences a total of 6 million francs (240,000*l*.) paid in wages.

"With regard to the establishments which are within the jurisdiction of the War Ministry, the nine-hour day was tried in a few instances and was then applied generally. The eight-hour day has been tried in one of these, an engineering works employing about 1,500 men, but the experiment was abandoned, and this would lead to the belief that the results were not favorable, notwithstanding the eagerness of the men who wanted the measure to become permanent. The fact is that in the works in question the eight-hour day led to a considerable increase in outlay. The conclusion arrived at in this case was that reductions in the number of working hours could, at best, only take place gradually, following improvements in machinery and in processes of manufacture; and this is exactly what will take place in private works when they are left alone to carry out their transformations, and are not pestered by ignorant legislators, whose chief object in life is, after all, the security of their seats. Such a movement has, in fact, taken place gradually from the commencement of last century.

"State establishments in every country are as badly placed as can be for carrying out experiments in this matter; none of their work is carried out on sound commercial or industrial lines. The experiments made in the French State establishments, and briefly outlined above, have, at all events, proved one point—that a reduction in the hours of labor corresponds immediately to a reduction in output and to a large increase in cost."

THE ECONOMICAL UTILIZATION OF LABOR.

A DISCUSSION OF THE BEST MEANS OF ATTAINING EFFICIENCY AND ECONOMY OF LABOR IN INDUSTRIAL OPERATIONS.

Henry L. Gantt—Stevens Indicator.

OF all the problems connected with industrial operation, none is of higher importance than the development of such a scheme of management as will obtain the most efficient and economical utilization of labor, but it is only within recent years that the subject has been given the attention it deserves. It requires but little study of the question to demonstrate the enormous gain in the efficiency of workmen when provided with proper tools and under proper direction, but the best results can be obtained only by exhaustive and careful research. The monumental researches of Fred W. Taylor on machine-shop practice are a conclusive proof of the value of scientific investigation. In an address delivered at the Stevens Institute of Technology, published in a recent number of the *Stevens Indicator*, Mr. Henry L. Gantt, who was associated with Mr. Taylor for a great many years, outlines the principles on which such investigations must be undertaken and the results which may be expected from the application of the "Taylor method" to industrial operation.

"Wherever any attempt is made to do work economically the compensation of the workman is based more or less accurately on the efficiency of his labor. Very fair success in doing this has been accomplished in day work by keeping an exact record of the work done each day by every man and by fixing his compensation accordingly. This method, however, falls very far short of the highest efficiency, for very few workmen know the best way of doing a piece of work, and almost none have the ability to investigate different methods and select the best. It often happens then that a man working as hard as he can falls very far short of what can be done, on account of employing inferior methods, inferior tools, or both.

"In order to get the best results the following conditions are necessary: (1) Complete and exact knowledge of the best way of doing the work, proper appliances, and materials; (2) an instructor competent and willing to teach the workman how to make use of this information; (3) wages for efficient work high enough to make a competent man feel that they are worth striving for; (4) a distinct loss in wages in case a certain degree of efficiency is not maintained.

"These conditions are really the steps

that must be taken to get any piece of work done efficiently: (1) Learn how to do it right, and how long it should take; (2) teach a workman to do it in the manner and time set; (3) award the workman greater compensation for doing it in the manner and time set than he can ordinarily earn in any other manner; (4) make the conditions of pay such that if he fails to do the work either in the manner or time set he gets only his day's pay.

"Let us study these steps one at a time. The first is a scientific investigation of how to do the work and how long it should take. The fact that any operation, no matter how complicated, can be resolved into a series of simple operations, is the key to the solution of many problems. Study leads to the conclusion that complicated operations are always composed of a number of simple operations, and that the number of elementary operations is often smaller than the number of complicated operations of which they form the parts. The logical method, therefore, of studying a complicated operation is to study the simple operations of which it is composed, a thorough knowledge of which will always throw a great deal of light on the complex operation. Also, the time needed for performing any complex operation depends upon the time of performing the simple operations of which it is composed. The natural method, then, of studying a complex operation is to study its component elementary operations. Such an investigation divides itself into three parts, as follows: an analysis of the operation into its elements; a study of these elements separately; a synthesis or putting together the results of our study.

"It is well known that nearly every operation can be, and in actual work is, performed in a number of different ways; and it is self-evident that all of these ways are not equally efficient. As a rule, some of the methods employed are so obviously inefficient that they may be discarded at once, but it is often a problem of considerable difficulty to find out the best method. It is only by a scientific investigation that we can hope even to approximate the best solution of any problem.

"To analyze every job and make out instructions as to how to perform each of the elementary operations requires a great deal of knowledge, much of which is difficult to acquire; but the results obtained by this method of working are so great that the expenditure to acquire the knowledge is comparatively insignificant.

"Experience has shown that whether the labor is that of a Pennsylvania Dutch workman in a machine shop, a Hungarian laborer handling stock in the yard of a steel works, or a skilled cloth handler in a bleachery, the amount of work the average workman does under the ordinary conditions is only about one-third of what can be done by a proper workman under the best conditions. I could give other illustrations of this ratio, which seems to be fairly uniform. When a man sets his own task, as he virtually does in ordinary day work, he usually does about one-third of what a good man fitted for the work can do under the best conditions.

"As a result of our first step or our scientific investigation, in general, we find that it is possible, to do about three times as much as is being done; the next problem is how to get it done. No matter how thoroughly convinced we may be of the proper method of doing a piece of work and of the time it should take, we cannot compel a man to do it unless he is convinced that in the long run it will be to his advantage. We must go about the work in such a manner that the workman will have confidence in us and feel that the compensation offered will be permanent.

"When this condition of affairs is established we are ready to start a workman on the task, which, when properly set after an investigation, is such as can be done only by a skilled workman working at his best normal speed.

"The average workman will seldom be able at first to do more than two-thirds of the task, and as a rule not more than one out of five will be able to perform the task at first. By constant effort, however, the best workman soon becomes efficient, and even the slower ones often learn to perform tasks which for months seemed entirely beyond them. I dwell upon this subject, for the task must be such as can only be performed by industrious, skilled workers.

"If we have at hand such people that

already have confidence in us and are willing to do as we ask, the problem of getting our task work started is easy. This, however, is frequently not the case, and a long course of training is necessary before we can teach even one workman to perform his task regularly, for workmen are very reluctant to go through a course of training to get a reward, especially when they are being told on all sides, as is usually the case, that the high price offered will be cut as soon as they can earn it easily.

"Buying labor is one of the most important operations in modern manufacturing, yet it is one that is given the least amount of study. Most shops have expert financiers, expert designers, expert salesmen and expert purchasing agents—for everything except labor. The buying of labor is usually left to people whose special work is something else, with the result that it is usually done in a manner that is very unsatisfactory to buyer and seller. It is admitted to be the hardest problem we have to face in manufacturing to-day, and yet it is only considered when the manager 'has time' or has 'to take time,' or on account of 'labor trouble.' The time to study this subject is not when labor trouble is brewing, but when things are running smoothly and employer and employee have confidence in each other.

"Men as a whole (not mechanics only) prefer to sell their time rather than their labor, and to perform in that time the amount of labor they consider proper for the pay received. In other words, they prefer to work by the day and be themselves the judges of the amount of work they shall do in that day, thus fixing absolutely the price of labor without regard to the wishes of the employer who pays the bill.

"While men prefer as a rule to sell their time and themselves determine the amount of work they will do in that time, a very large number of them are willing to do any reasonable amount of work the employer may specify in that time, provided only they are shown how it can be done and paid substantial amounts of money for doing it. The additional amount needed to make men do as much work as they can depends upon how hard or disagreeable the work is and varies from 20 to 100 per cent. of their day rate.

"If the work is light and the workman is not physically tired at the end of the day he will follow instructions and do all the work called for if he can earn from 20 to 30 per cent. in addition to his usual day's wages. If the work is severe and he is physically tired at the end of the day he requires from 40 to 60 per cent. additional to make him do his work. If in addition to being physically tired he has been obliged to work under disagreeable conditions or in intense heat, he may require 70 per cent. or even 100 per cent. additional.

"These facts are derived from experience and give us a key to the intelligent purchase of labor. For instance, if we wish to buy the amount of labor needed to accomplish a certain task, we must find out exactly and in detail the best method of doing the work, and then how many hours' labor of a man suited to the task working at his best normal rate and by the methods prescribed are needed to perform it.

"Most men will not sacrifice their present wages to earn a higher reward in the future, and even if they were willing few men could afford to. Therefore, while they are learning to perform the task, they must then be able to earn their usual daily wages, and the reward for the accomplishment of the task must come in the form of a bonus above their daily wage.

"As before noted a proper task is always greater than the ordinary workman can perform at first, and must be such as only the most skilled can perform. On the other hand, when the more skilled have been earning their bonus for some time, and the less skilled begin to realize that the prize is real and worth striving for, they make every effort to attain it and rapidly improve in skill.

"This increase in efficiency makes the payment of high wages possible, and it may be added that without efficient labor, permanent high wages cannot be paid indefinitely, for every wasteful operation, every mistake, every useless move has to be paid for by somebody and in the long run the workman has to bear his share.

"Good management, in which the number of mistakes is reduced to a minimum, and useless, or wasteful operations eliminated, is so different from poor management, in which no systematic attempt is made to do away with these troubles, that a man who has always worked under the latter finds it extremely difficult to form a conception of the former. The best type of management is that in which all the available knowledge is utilized to plan all work, and when the work is done strictly in accordance with the plans made. In other words, that management is best which utilizes labor in the most efficient manner.

"The best mechanical equipment of a plant that money can buy avails but little if labor is not properly utilized. On the other hand, the efficient utilization of labor will often overcome the handicap of a very poor mechanical equipment, and an engineer can have no greater asset than the ability to handle labor efficiently."

THE ARTIFICIAL DISPERSION OF FOG.

A DISCUSSION OF THE NATURE AND CAUSES OF FOG AND OF MEANS OF DISPELLING IT ON SEA AND LAND.

M. M. Dibos—Société des Ingénieurs Civils de France.

THE prevalence of fog on the west coast of Europe, creating a constant danger to the shipping of the British Isles and of France, has for many years turned the attention of physicists to the problem of its artificial dispersion. Some of the most important researches carried out within recent years have been those of a French engineer, M. Dibos, and a recent paper before the Société des Ingénieurs Civils de France outlines the results he has obtained.

When the temperature of the atmosphere falls below the saturation point, its content of water vapor condenses in the form of fine drops of water which remain in suspension in the air on account of their extreme smallness and the resistance of the air to their fall. The researches of Aitken have shown that for the formation of fogs the suspension of the minute particles of water must be made more or less permanent by association with extremely fine grains of dust. The microscopic particles of solid matter found in the atmosphere come from a great variety of sources. Inorganic matter is found in great abundance, caused sometimes by volcanic eruptions, but more usually a product of combustion or of the disintegration of the earth's crust; but in addition is found a multitude of organic substances of which the origin and nature are sometimes indeterminate. Atmospheric dust is, of course, found in greatest quantities on land, especially near large centres of population where smoke plays an important part in its production; but considerable quantities have been found at sea at great distances from land, whence they had been carried by high winds and by normal currents of air. Wherever they occur these particles have the property, under suitable conditions of temperature and pressure, of condensing on themselves the water vapor in the air. The small globules of water thus formed, each containing a particle of dust, remain suspended in the air in a state of unstable equilibrium and their accumulation produces fogs of greater or less density.

In 1899 M. Dibos happened to be on board a Channel steamer which ran into a dense bank of fog. He noticed that in the immediate vicinity of the mouth of one of the stoke-hole ventilators there was a clear space of considerable size. He immediately conceived the idea that the mechanical shock of the heated air destroyed the equilibrium of the particles of water and caused them to fall. A few experiments with a small fan confirmed this opinion. Convinced, therefore, that a much larger space might be cleared by the projection of heated air under considerable pressure, M. Dibos continued his researches and devised a simple apparatus which under test produced in a dense fog a clear space over 200 yards long.

M. Dibos' first apparatus, which was especially adapted for use on steamships, consisted essentially of a cast-steel, steam-jacketed cylinder, communicating with the outer air by means of a pipe fitted with a valve and bent so that the axis of the cone-shaped, copper mouthpiece was horizontal. In foggy weather compressed air was piped into this cylinder, heated by the steam circulating in the steam jacket and then discharged into the fog. The discharge pipe was pivoted so that the compressed air could be discharged in any direction.

Continuing his researches M. Dibos decided to experiment with electric waves which he thought could be so utilized as to give better results than he had obtained with heated air and in 1904 he installed an apparatus at Wimereux-Plage, near Calais. In this installation electrical energy at a potential of 140,000 volts from an electrostatic machine was discharged into the air from a series of copper points. These points were about 80 feet above the ground. Several tests made in an extremely dense fog showed that electric waves at this potential can produce a complete dispersion of fog within a radius of from 50 to 60 yards.

M. Dibos considers that his researches are as yet in a very incomplete state. He is convinced, however, that electro-static machines are not well adapted for the generation of high-voltage electricity for fog dispersion on account of the fact that such machines are much affected by dampness. Within the next few years, it is reasonable to suppose that further developments will produce apparatus which will be powerful enough to disperse fog for a radius of at least 400 yards. The importance of the problem can hardly be overestimated, particularly in connection with the shipping industry. Its application in connection with railway signal systems also is only a matter of time, the Northern Railway of France having already installed an experimental station at its Paris terminal.

SEISMIC DISTURBANCES AND COLLIERY EXPLOSIONS.

A DISCUSSION OF THE REMARKABLE ASSOCIATION OF COLLIERY EXPLOSIONS WITH PERIODS OF SEISMIC DISTURBANCE.

James T. Beard—Engineering and Mining Journal.

THE important subject of the causes of colliery explosions is interestingly treated by Mr. James T. Beard in a recent number of the *Engineering and Mining Journal.* After discussing the faults of management and the carelessness of inspectors and laborers to which coal-mine disasters are so often due, Mr. Beard turns to a consideration of the natural agencies which affect the explosive condition of mine air. While he grants that barometric pressure has a certain influence, he considers that by far the greatest factor in the formation and liberation of gas in collieries is seismic disturbance.

"I have yet to mention an agency that is probably responsible for explosive conditions in mines to a greater extent than any yet named. I referred a year ago, in an article on mine explosions, to the lack of attention given by mining men to the variation of pressure of gas that may occur within the strata, from whence mine gases emanate. I believe as the result of several years' close observation that internal pressure is the cause of larger, spasmodic emissions of gas. The ground for this belief, which is at least reasonable, is as follows: It is a matter of general observation that the flow of gas in all mines located in regions or districts where gas may be expected is spasmodic. Even in districts producing large quantities of gas and which therefore appear to furnish a constant emission, there is a very perceptible ebb and flow, causing periods or fluctuations in the gaseous condition of the mines. In other districts and mines there are corresponding periods in which much gas is given off, followed by intervals where there is almost an entire absence of gas in quantities to cause alarm. Often these periods of the ebb and flow of gas from the strata are quite local, that is, restricted to a limited area or district, and at times appearing in a single mine or portion of a mine only. Several instances have recently occurred where the flow of gas increased in a portion of the mine so rapidly that the men were withdrawn from that district and not permitted to return for nearly a month when the flow ceased almost entirely.

"Observations such as the foregoing

prove quite conclusively the existence of conditions or agencies that affect the emission of gas locally and from within. No atmospheric changes could produce local phenomena such as these. We possess very little exact knowledge of the condition of the interior of the earth, but the evidence of volcanoes in action and our knowledge of the agency of heat and pressure make it certain that tremendous activities are in constant operation within the earth's sphere. It is both natural and reasonable to suppose that the pressures in subterranean channels that will discharge molten material under the great head due to the height of a volcano, can make themselves felt in other quarters, and incidentally augment the outflow of gas from strata already pregnant. No one familiar with underground conditions and who has listened with awe to the mysterious "poundings" in the overburden of a mine, caused, as is well known, by the working of gas in the foliations of the strata, can study the phenomena of earthquake waves and shocks without being convinced of the close relationship of the different phenomena. The conclusion is fairly certain that gas generated by the chemical and physical activities within the earth plays an important part in all these phenomena.

"I have previously drawn attention to the close association of volcanic activity and mine explosions, and will only briefly refer to these here. The theory of spasmodic or irregular earth breathings, as just explained, if true, would give rise to periods of frequency of mine explosions, more or less closely associated with volcanic activity. That such is the actual fact is shown to be highly probable by the remarkable coincidence in their occurrence. That there are isolated or errant mine explosions occurring in a period of rest and entirely dissociated from seismic disturbance, does not argue against the theory, since it is not claimed that all mine explosions are the result of such disturbance. The causes producing explosive conditions in mines are too numerous to invite such an expectation. But when periods of marked seismic troubles are almost invariably accompanied by the appearance of gas in increased quantities in mine workings, and the occurrence of one or more mine explosions, the fact is significant of something more than mere chance.

"The terrible eruption of Mt. Pelée that devastated the island of Martinique, West Indies, May 20, 1902, was accompanied by four prominent mine explosions in a period of less than three months, causing the loss of 550 lives. Two of these explosions occurred at practically the same time as the principal eruption of the volcano. The record is as follows: May 19, 1902, Fraytervile, Tenn., explosion, 184 lives; May 20, 1902, Mt. Pelée, eruption, 28,000; May 23, 1902, Fernie, B. C., explosion, 127; July 10, 1902, Johnstown, Penn., explosion, 112; August 1, 1902, Wallangong, N. S. W., explosion, 127.

"This was followed by two or three years of comparative rest, only to be succeeded by a still more terrible and prolonged season of disquiet. From early in the year 1905 to the present time there has been an unbroken succession of seismic disturbances marked by some of the most terrible mine disasters ever recorded. The record of the principal occurrences is as follows: January 4 to 24, 1906, three mine explosions, United States, 54 lives; February 8, 1906, Parral, W. Va., explosion, 27; February 19, 1906, Maitland, Colo., explosion, 16; February 21, 1906, Colombia, S. A., earthquake, 2,000; February 27, 1906, Piper, Ala., explosion, 9; March 10, 1906, Pas-de-Calais, France, Courrières explosion, 1,200; March 17, 1906, Formosa, Japan, earthquake, 3,000; March 22, 1906, Century, W. Va., explosion, 21; March 28, 1906, Takashima, Japan, explosion, 307; April 3 to 17, 1906, Vesuvius, Sicily, 500; April 7, 1906, Formosa, Japan, earthquake, 109; April 18, 1906, San Francisco, Cal., earthquake, 2,000; April 20, 1906, Calumet, Mich., fatal; April 20, 1906, Honolulu, fatal; April 21, 1906, Trinidad, Colo., 23."

Mr. Beard enumerates many other minor disasters and concludes:

"These terrible records tell significantly of the danger that exists in mine workings during periods of seismic unrest. Undoubtedly much trouble has been avoided by the increased vigilance and care exercised of late in mines by reason of the attention that has been drawn to the subject, and it is to be hoped mine officials will not relax precautions."

DEPRECIATION OF ELECTRICAL PLANTS.

A DISCUSSION OF THE NECESSITY OF PROVIDING DEPRECIATION AND ANTIQUATION FUNDS IN ELECTRICAL OPERATIONS.

Robert Hammond—Institution of Electrical Engineers.

THE determination of the method and amount of the provision which should be made for depreciation of plant and machinery is one of the most perplexing problems in the economics of industrial operation. The necessity of making allowance for depreciation in the annual balance-sheet is universally recognized, but the methods of making such allowance are many and based on widely differing principles. This is particularly the case in electrical-supply undertakings in which development has been so rapid as to prevent the formulation of any standard rules on the subject. A recent paper by Mr. Robert Hammond, read before the Institution of Electrical Engineers, gives an interesting discussion of the various theories in regard to the provision for depreciation in electrical plants.

"In arriving at the net profits earned during any given period by an industrial undertaking, it is obvious that a determination should be made of the extent to which the assets of the undertaking have depreciated in value during that period. Where machinery and apparatus are employed it is necessary to estimate their probable 'life,' which, in the case of undertakings working on well-established lines, may be easily arrived at. Having fixed a definite figure for the life, the sum which is equivalent to the annual depreciation of the machinery and apparatus may be written off annually and debited to the gross profits, this book entry involving no withdrawal of money from the undertaking; or out of the gross profits annual investments may be made of such sums as will, at compound interest, reach the amount of the original cost of the machinery and apparatus by the time that they are worn out.

"Turning to electricity supply undertakings, one finds that their development has been so rapid, and the working conditions have so greatly altered in so short a time, that no standard method has yet been agreed upon for dealing with the question of depreciation, and no definite course has been pursued. The word 'depreciation' is used in a wide sense, and it is desired to include in this inquiry not only the consideration of the provision which should be made to cover the depreciation in value of the assets of an undertaking, but also as to what other charges beyond the ordinary working costs should be debited to the revenue account before arriving at the net profits of the undertaking. Following these lines, we have first to consider the question of depreciation proper, then the advisability of creating a reserve fund to provide for unforeseen expenses which may be incurred owing to accident or other emergency, and, lastly, the provision of a further fund to cover antiquation of machinery, apparatus, and mains, thereby preparing for the possible necessity of scrapping machinery, etc., which may be in good working order, but which may have become obsolete owing to improvements introduced in methods of generation and distribution. . . . . .

"The conditions governing the working of electrical supply undertakings are such that, in order to give a continuous supply of electricity, it is essential that machinery, apparatus, and mains should be kept in a high state of efficiency. The cost of so maintaining the plant is, of course, regarded as part of the working costs, and is assumed to be so dealt with. Plant, well maintained as it may be, must, however, gradually depreciate, and a time will come when the frequency and extent of repairs and renewals necessitate so heavy an item of annual expenditure that it is preferable to replace it with entirely new plant. In order to arrive at the amount with which the gross profits should be debited annually in order to cover this depreciation, it is necessary to settle the number of years which will elapse before the various classes of plant and apparatus in use will arrive at the scrapping stage and will require entire renewal. At the outset we are confronted with the difficulty that the life of machinery so largely depends upon the way in which it is maintained, that a definite period at which any particular class of machinery or apparatus would in the ordinary course be entirely worn out can hardly be taken as of universal application. On the basis, however, that all plant would be carefully maintained and faulty parts renewed out of revenue, it is suggested that the periods named below represent a fair approximation of the life of the various classes of machinery and apparatus, etc., named:

Estimated Years of Life.

Land and buildings	60
Machinery and plant—Boilers	20
Pumps and pipework	25
Conveyors	10
Engines	25
Turbines	20
Dynamos and alternators	25
Motors	20
Tools and sundries	10
Accumulators	15
Transformers, static	15
Converters, rotary	20
Switching apparatus and instruments	20
Meters	10
Mains—Armoured	25
Solid system	30
Ducts	30

"If the above periods be accepted, it becomes a simple calculation as to the amount which must annually be written off or set aside to a sinking fund.

"Reference has already been made to the alternative methods of dealing with the depreciation fund. Of those methods doubtless the sounder is that which provides for the annual investment, outside the undertaking, of such sums as will, accumulated at compound interest, represent from time to time the actual ageing of the machinery, apparatus, mains, etc. It is true that if this method were adopted, each extension of the undertaking would necessitate the raising of fresh capital which would have to be subscribed either by the existing shareholders or by the general public. Although this might cause inconvenience, yet, nevertheless, it is urged that by this method a far more definite control would be established over the growth of the undertaking, and the shareholders would have the option of either investing or refraining from investing further capital in it instead of being compelled to do so through the investment of the depreciation fund monies in it.

"It is also urged that should the course advocated be pursued the company with such an asset at its back would be in a far more favourable position as regards the issue of fresh share capital than it would be if it had invested its depreciation fund in extensions and was compelled to go to the public for more capital, at a time when a large proportion of its machinery and plant had become worn out.

"In support of this contention it is pointed out that in many undertakings, not only is the existing plant written down in value in the balance sheet, but since the balance so obtained does not exist in cash, it has been considered necessary to form a separate fund, called a renewals fund, which is retained as cash for the purpose of renewing such items as have an exceedingly short life, such as the track in a tramway undertaking.

"It seems to be unreasonable that profits should be debited not only with depreciation, but also with contributions to a renewals fund. If the depreciation fund existed in readily convertible securities instead of being invested in the undertaking for extensions and the like, it would be available, in the case of a tramway company, to renew the track as soon as the rails were worn out, and the monies otherwise placed to the renewal fund would have been distributed as profits.

"One, of course, gets back to the fact that for the purpose of extensions, fresh issues of capital would be required from time to time, and most directors would doubtless think it preferable to use the money which they had actually in hand before they made an appeal to their shareholders or to the outside public for further share capital. This, indeed, is the method that has almost universally been adopted by the electricity supply companies operating in London.

"As regards the second item, to which reference has already been made as coming within the purview of the paper, namely, the provision of a general reserve fund, it seems to the author that, however wise the formation of a general reserve fund might be for the purpose of equalisation of dividends, it nevertheless does not rank as a strict necessity as does a depreciation fund. Further, he does not agree with those who hold that such a fund is necessary, not only for the equalisation of dividends, but for the purpose of providing against extraordinary expenditure due to unforeseen emergencies. Such emergencies are causes by accident in one form or another, and such risks should be fully insured against and the premiums regarded as part of the ordinary working costs.

"Lastly, there is to be considered whether a fund to cover antiquation should be deemed obligatory. It has been urged on the one hand that no provision whatever need be made under this heading. Those who hold this view contend that any great revolution in engineering methods which would cause their present plant to become obsolete would necessarily carry with it its own advantages, either in the direction of a great improvement in efficiency or in an extension of the uses to which electricity might be put. They contend that these advantages if really extensive would in themselves more than pay for their adoption, and that unless a company could see its way to larger dividends by adopting an improvement, it would, of course, continue on the old lines.

"On the other hand, many hold the view that an antiquation fund is of vital importance, and they point out that a radical improvement might arise which entirely superseded the existing methods of generation and distribution, and while such an improvement would entirely take the field in opposition to the present methods, nevertheless the improvement might not carry with itself a sufficient margin of profit to cope with the dead weight of interest on capital expended upon superseded plant. A company without an antiquation fund would then be faced by the possible competition of a new concern not so over-burdened with capital charges which would completely relieve them of their business.

"The author does not share the latter view to the full extent, but, on the other hand, he thinks that no electricity supply undertaking can be regarded as in a thoroughly sound position unless some provision has been made in the direction of an antiquation fund. At the same time this provision is, in his opinion, not one which would rank on the same footing as a depreciation fund *per se*, but is one which might wisely be contributed to out of profits as a sort of nest-egg for the future.

"To arrive at an absolutely accurate amount of annual contribution to a depreciation fund it would be necessary to determine the residual value of the machinery, apparatus, etc., at the end of their respective lives. In the case of land it, of course, remains, and the scrap value of machinery, apparatus, mains, etc., containing a fair amount of copper and other metals, is appreciable. As, however, a depreciation fund must in its nature be based upon an estimate, it has seemed to the author wise to regard the residual value as an item which the undertaking would have to the good at the end of the respective lives, and one which to that extent would be in hand as a contribution towards the cost of new plant."

THE BRENNAN MONO-RAILWAY.

AN APPLICATION OF THE PRINCIPLE OF THE GYROSCOPE TO TRANSPORTATION PROBLEMS.

The Electrician.

MR. LOUIS BRENNAN, the inventor of the Brennan torpedo, recently turned his attention to the application of the gyroscope to transportation problems and has produced a monorail car which is considered, in some quarters, to be destined to revolutionize railway operation. A small model of the car, shown recently at a meeting of the Royal Society, amply demonstrated the practicability of the system, showing remarkable stability under most difficult conditions. A recent number of *The Electrician* gives some details of the system and outlines the advantages claimed for it.

"The characteristic feature of this system of transport is that each vehicle is capable of maintaining its balance upon an ordinary rail laid upon sleepers on the ground, whether it is standing still or moving in either direction at any speed, notwithstanding that the centre of gravity is several feet above the rail, and that wind-pressure, shifting of load, centrifugal action or any combination of these forces may tend to upset it.

"Automatic stability mechanism of extreme simplicity, carried by the vehicle itself, endows it with this power. The mechanism consists essentially of two flywheels rotated directly by electric motors in opposite directions at very high speed, and mounted so that their gyrostatic action and stored up energy can be utilized. These flywheels are mounted on special bearings, and are placed in cases from which the air has been exhausted, so that both air and journal friction is reduced to a minimum, and consequently the power required to keep them in rapid motion is very small. It is stated that the stored up energy in the flywheels of the larger vehicles when revolving at full speed will be so great and the friction so small that if the driving current is cut off altogether they will run at sufficient velocity to impart stability to the vehicle for several hours, while it will take from two to three days before they come to rest.

"The stability mechanism occupies but little space and is conveniently placed in the cab at one end of the vehicle. Its weight is also small, about 5 per cent. of the total load being considered an ample allowance for the first vehicle.

"The road wheels are placed in a single row beneath the centre of the vehicles, instead of in two rows near the sides as usual, and are carried on bogies or compound bogies, which are not only pivoted to provide for horizontal curves on the track, but for vertical ones also. By this means the vehicles can run upon curves of even less radius than the length of the vehicle itself, or on crooked rails or rails laid over uneven ground without danger of derailment.

"The motive power may be either steam, petrol, oil, gas or electricity, as considered most suitable for local conditions. In the full-sized vehicle now being built, however, it has been decided to use a petrol-electric generating set, for the supply of current to the road wheel motors and to the stability mechanism. Such a vehicle will have the great advantage of being always ready for immediate use, the gyroscope wheels being kept constantly running by current from a small battery of accumulators while the engine is at rest.

"In order that the vehicle may be able to ascend steep inclines the wheels will be power driven, and change gears provided for use in hilly country. It is also possible to run free wheel down hill at a high velocity, so that a good average speed can be maintained.

"The system points to great economy resulting from making the vehicles wider in proportion to their length than on ordinary railways, and it has, therefore, been decided to make the experimental waggon 12 ft. wide, or one and a half times as wide as usual. For civil work in the colonies the vehicles will probably be two or three times as wide, if not more.

"Brakes capable of being operated by pneumatic or manual power will be provided for all the wheels.

"The rail, which is of ordinary section, only requires to be the same weight as one of the rails on an ordinary line in order to carry the same load on the same number of wheels in each case. The sleepers also only require to be one-half the length to give the same area of support to the vehicle.

"Flying lines of railway can be laid with great rapidity over uneven ground with slight expenditure of labor, specially-designed building-vehicles, also on the monorail principle, equipped with electric gear for handling the rails, being kept at the rail head for the purpose. It is confidently anticipated that, working in this manner, it will be possible to keep up with an army on the march, and supply them with all their requirements.

"For temporary work, bridges may be of the simplest possible construction, a single wire hawser stretched across a ravine or river being all that is necessary. These hawsers can be built up on the spot from separate wire rope strands, so that the transportation of them becomes an easy matter. It is stated that lateral swaying of the hawser will not disturb the balance of the vehicles, and that the strongest winds will not blow them off. In other cases of bridge building, a single row of piles with a rail on top will suffice, or a single girder carrying the rail may be conveniently used.

"The expenditure of fuel is expected to be smaller than on ordinary lines, owing to the absence of flange friction on curves, and to the vehicles running without oscillation or jolting.

"The speed may be from twice to thrice that of ordinary railways owing to the smoothness of running of the vehicles, and to the total absence of lateral oscillation.

"Vehicles provided with their own motive power can go wherever a single rail is laid, and, besides carrying a substantial load themselves, are also capable, on tolerably level country, of supplying current to other vehicles unprovided with power-generating plant.

"The advantages claimed by the inventor for his system are:

1. Almost incredible speeds are expected to be attained on high-class lines laid on this system, owing to the total absence of lateral oscillation caused on ordinary lines by the impossibility of laying two lines exactly level and parallel with each other. From twice to thrice ordinary railway speeds are to be expected.

2. The fact that the vehicles lean inwards to the correct angle when taking curves secures them from derailment at the highest speeds. The curves would, of course, have to be suitably approached to give the vehicle the time necessary to assume the proper inclination at the particular speed adopted and the line would have to be laid accordingly.

3. It is certain that for "high-class" transcontinental lines, the vehicles will be very large, so large indeed that they will more resemble ships on shore, or traveling hotels, than vehicles as we know them now.

4. Perfect comfort in traveling owing to there being no oscillation.

5. Saving of material required for construction of line in the way of rails, bridges, sleepers, etc.

6. Small first cost and small cost of maintenance.

7. Traveling will be much safer owing to the absence of danger of derailment at high speeds."

THE PROFESSIONAL IDEALS OF THE TWENTIETH CENTURY.

A PLEA FOR THE HIGHER CONCEPTION OF THE ENGINEER'S RELATION TO SOCIETY.

Arthur Twining Hadley—Dedication of the United Engineering Societies' Building.

THE progress of civilization in the nineteenth century is generally conceded to have been due largely to the development of applied science. Engineering, therefore, which a hundred years ago was but a subordinate branch of the military art, has become a dominant factor in the material development of nations and to-day the engineering profession is recognized as the most important part of industrial and commercial organization. The commercialism of the age is, however, likely to prevent the development of the engineer as a factor in the social and political life of his country. At the recent dedicatory exercises of the building of the United Engineering Societies, President Hadley of Yale University discussed the opportunities of the engineer for public service and made a plea for a higher conception of professional ethics.

"The great element of progress in the nineteenth century has been the recognition on the part of mankind in general, of the value of scientific generalizations in every department of human conduct. Our science has become sounder, our understanding of its applications clearer, and the public has recognized that scientific conduct of a business means the substitution of universal experience, learned with difficulty and applied with toil, for the narrower range of individual experience which was at the disposal of the so-called practical men of fifty or a hundred years ago. Of this change the engineer is the representative and the leader. He it is that makes physical science in its various lines applicable to the complex problems of construction and development. He it is who has paved the way for the recognition of the technologist and the expert in every line of human industry. He it is who has shown how mathematics, instead of being an abstract discipline, remote from every day human affairs may become the means of applying truths for a long time remote and undiscovered, to the every day affairs of the world in which we live. Not the buildings that you have built; not the railroads that you have planned; not the machines that you have invented, represent your greatest achievement. Yours is the proud boast of having in one brief century established science as the arbiter of the material affairs of mankind, and of having enforced her worship upon a world once reluctant, but now gloriously admiring.

"Well, then, you will ask: is there anything which remains to be done comparable in importance to this? Yes, there is. An equally large part—perhaps in one sense a much larger part—of your professional duty yet remains to be accomplished. It is not enough to have technical training. It is not enough to know the special sciences on which the practice of a profession is based. A man ought to have clear conceptions of the public service which his profession can render, and the public duty which its members owe. Thus, and thus only, can the engineer, the lawyer, the physician, or a member of any other learned profession, rise to the full dignity of his calling.

"For there are two quite distinct qualities which must be combined in order to secure the best professional services; two quite distinct tests which work must meet in order to be pronounced first class. One of these is the technical standard; the other, for want of better word, may be called the ethical standard. The man who wishes to build a good railroad must not only lay it out according to the rules of the surveyor's art, with proper curves and grades, and bridges which will not fall, but he must also have intelligent regard to the needs of the population, the safety of travel, and the many other factors which determine whether a railroad shall be a work of public use or a source of industrial bickering and financial disaster. This combination of public and private demands is not peculiar to engineering. It can be illustrated in every other profession of importance. It is not enough for the lawyer to give advice which shall be technically sound, and which shall enable his clients to keep out of jail. He must learn to take a large view of the law as a means of public service instead of private gain. It is not enough for the physician to know how to cure specific diseases. He must know how to care for the larger problems of public health, and to use the resources of the community in a way to meet as fully as possible its sanitary needs.

"This larger view of professional obligations is not so fully recognized as it should be. We have in the nineteenth century made so much progress in the technical training of doctors and lawyers and engineers that we sometimes forget that there is need of anything more than technical training. We have let the old idea of public leadership, which was prominent in the minds of the great professional men of past centuries, give place to another and narrower ideal which is fully satisfied when a man has made himself a technical expert. Many a man of real eminence in his calling deliberately rejects the wider conception of professional duty which I have here indicated. Perhaps he recognizes the claims of public service; perhaps he does not, but in any event he believes that these claims rest upon him as a man rather than as an engineer or a lawyer. In his professional capacity he says he is hired not to tell what the law ought to be, but what it is; not to advise how a railroad can do the most public service, but how certain men with certain ideas of their own can best use the differential calculus to get these ideas carried out. This is perhaps the prevalent view of professional ethics to-day. I believe that it is a wrong view, which must menace not only the influence and standing of the professions themselves, but the general interests of the republic.

"Mere technical achievement is not the thing that endures. Among the peoples of the ancient world, I suppose that there were no engineers equal to those of Egypt. Considering the means at their command, the things they did were absolutely extraordinary. They did some things which, even with the means at our command, we can hardly duplicate. But they used their abilities in the service of a dominant priestly caste; and therefore, while their work fills us with admiration, it does not appeal to us as does the work of the Roman engineers a few centuries later, who built roads and aqueducts and bridges, and thus took the lead side by side with the Roman lawyers in establishing the basis of modern civilization. The roads and bridges of Rome, simple and straightforward as they are, constitute a more enduring monument to the Roman engineers than all the obelisks and pyramids that were ever erected.

"A commonwealth like that of the United States is necessarily governed by public opinion. Courts may formulate this opinion. Legislatures may pass rules to give effect to it. Police may enforce its demands against the recalcitrant. But the governing power rests in the intelligent public opinion itself. When that opinion ceases to be intelligent and powerful, freedom becomes a mere name. Now, a serviceable public opinion of this kind can only be formed when intelligent people, technically trained for different lines of life, seriously try to find out how their work can be made to meet the public needs. They are the only ones who can do this well. If it is done by anybody else it will be done badly. If the lawyers as a class try to keep the law in line with the demands of intelligent public opinion, we can get good law. But if the lawyers are content to see the law perverted to private ends, and judges take refuge in technical construction of precedents, without full regard to the needs of the existing situation, legislatures will step in to create a chaos of conflicting laws which are worse than no law at all. In like manner, if our engineers get their own minds clear, and get the public mind clear, as to the political economy of the properties entrusted to their charge and the ethics of their management, they can forestall these conflicts which now threaten to break out at every moment. But if the members of a profession whose advice is necessary for a clear understanding and wise settlement of these problems retire from the field of action, the matter will be settled by those whose interests are more selfish and less far-sighted. There are three professions today which do not regard themselves as servants, but as masters—the financier, the journalist and the politician. If the engineer and the lawyer accept positions as servants, simply putting their technical knowledge at the disposal of merchant, journalist, or politician who will pay the highest price for it, it is not simply a confession of inferiority, it is a dereliction of public duty."

THE GAS-POWER SITUATION IN AMERICA.

A CRITICISM OF THE MANUFACTURING METHODS TO WHICH ARE DUE AMERICA'S SLOW PROGRESS IN THE APPLICATIONS OF GAS POWER.

F. E. Junge—Power.

ATTENTION has been drawn repeatedly in the columns of THE ENGINEERING MAGAZINE to the fact that the extreme systematization and specialization of American methods of manufacture are rapidly producing a stagnation which precludes the possibility of progress and improvement. In the June number Dr. Louis Bell pointed out the influence which the unwillingness of the American manufacturer to depart from standard types is having upon the trade of the country, drawing his illustrations from a great variety of industries. The status of gas power in the United States is one of the most striking examples of the paralyzing effects of excessive standardization on industrial progress. During the past two years Mr. F. E. Junge has contributed to *Power* a long series of articles on gas-engine practice in Europe and in a recent number of that magazine he gives his view of the reasons for the backward state of America in the development of the applications of gas power.

Mr. Junge first points out the enormous economic importance of the gas-power problem. In 1906 the aggregate power developed in the United States amounted to 14,465,000 horse power, of which 10,664,560 were developed from steam and only some 300,000 from gas. In the same year the coal consumption for power purposes was nearly 100,000,000 tons. "Figuring at an average price of $2 per ton, it is obvious that the universal adoption of a method of generation which will render an equivalent power service with one-half the consumption will represent an annual saving of some $100,000,000, disregarding entirely what the saving in fuel means to future generations."

Speaking of the literature on gas-power problems available in the United States, Mr. Junge says that it seems to be devoted to one of three aims: "The abstract study of the internal thermo-dynamic relations of gas-producing and converting apparatus; the quantitative side of design of their mechanisms, and the historical or inventive evolution of the problem. All of these modes of treatment are interesting in themselves and valuable in their combination. Perceptibly the cultivation of the mechanical engineering part, that is, the theory of the construction of gas producers and engines, as an expedient in the practical development in the art is most vital to the question, greatly more so than is a purely hypothetical analysis of the physical and chemical phenomena occurring in the working cycle.

"There is, however, one more side to the subject, which so far has been entirely neglected and the want of which is acutely felt by the trade, namely, the broad economic aspect of the gas-power problem, its relation to the iron, coal and kindred industries, and its scientific and impartial presentation to men, professional and mercantile. There should be more treatises to appeal to the interests of wider industrial and commercial circles, demonstrating the possibilities and clarifying the limitations of the application of gas power in the varied industries.

"The scarcity of good literature available on gas-power engineering in this country is due, in the first place, to the unfortunate but incontrovertible fact that those men whose learning and experience would enable them adequately to discuss and propagate the subject in professional circles are not permitted by the firms controlling their services to make public such data as would be of direct practical usefulness to the working engineer. To the foreign observer of American industrial methods this policy of reserve unquestionably appears distinct from the broad-minded course of action which is pursued by the majority of other governmental or private institutions. In fact, it seems dictated by traditional rather than by logical motives, since there certainly would be less injury done to the commercial interests of manufacturers by a liberal exchange of useful information than by promoting—as they deem wise to—the publication of literature of the sort that is nowadays distributed by their publicity men. Whether or not this hermit-like attitude of isolation and secrecy, as Dr. Lucke terms it, be beneficial to the earning end of manufacture, there can be no doubt that it works direct harm to the propagation of technical truth among professional men. It is owing to this very secrecy that the technical student of this branch of engineering cannot, except for the merely fundamental principles involved, rely on what form otherwise and elsewhere the most valuable sources of information, namely, the current technical periodicals, and the professional papers read before the national engineering societies. For the majority of material and discussion advanced, so far as it is not of an entirely academic nature, relates to efficiencies and performances of commercial machinery, being obtained from the advertising or publicity staffs of the large manufacturing concerns, who, no doubt, withhold all information except that which presents the good features, and those only, of their products.

"I am bold enough to go so far as to say that the commercial success of any novel machine depends, in this country, more on the ability of the sales department than on the real technical merits of its design. For it is conceded that fuel cost, which is still considered by some as a secondary factor in power-plant economics, is hardly ever ascertained, after a period of probation in practice, by impartial investigators, since manufacturers and users alike are yet pleased to get continuous and reliable service at almost any price. Satisfaction such as this, though comfortable for the builder, is far from conducive to further progress in the mechanic arts. In fact, it is prejudicial to it.

"Another obstacle, and one equally traceable to other lines of manufacture, is that after a few years of unchallenged growth too much capital has been invested in one special form or pattern, and not enough of skilled talent has been provided to allow of any radical changes to be instigated. Profit-making management, so long as it is concerned with present dealings only, must disapprove of the frequent alterations in design so essential in a developing field, because investors clamor for immediate returns, and for the greatest possible revenues from the capital invested.

"Progressive engineering in general, and our special branch in particular, would ultimately derive much greater benefit from careful experimental investigation and thorough scientific research, if the key-note of opportunism and immediacy were not so preponderatingly sounded: Immediate results, immediate satisfaction, immediate earnings! The full measure of prosperity in the fat years, and the ability to tide over the lean ones, are the results of forethought and preparation of a different character. The stability of modern industry requires that some money, some labor, and some time be expended for operations other than those which tend to produce the maximum income immediately.

"But here is where this special trouble is wedded to the lamentable plague of commercialized engineering which is threatening us to-day in all progressive countries: monopoly, the great discourager of effort in trade, manufacture and profession, will dictate the technical methods to be followed, thereby suppressing individual aspirations; few great corporations will buy up the highest grade of skilled talent, literary, inventive, mechanical, but will keep it latent or, at least, barren of creative work, by raising almost insuperable barriers to the propagation of the fruits of its labor.

"Gas-power engineering is no exception to the rule. It is in spite of the antagonistic attitudes exhibited by the large manufacturing corporations, and without their sanction that the writer has begun his campaign of publicity, moved by the earnest desire to reciprocate for the wealth of impressions received during his studies in this country, in setting before the ambitious and studious reader such achievements, and the ways for attaining them, as have been realized in this line abroad. Happily for the development of the art and for the purse of the power user, the destiny of this particular industry is not controlled yet, as is that of the electrical industry, by a few huge co-operating corporations, and an alternative to unsatisfactory dealing is still available. It is hoped that the vastness and multiplicity of interests involved in the gas-power field will effectively prevent centralization of the kind that precludes a stable and healthy industrial growth."

THE NEW HARBOR WORKS AT BRUGES.

A SUMMARY OF THE WORK BEGUN IN 1896 AND NOW NEARING COMPLETION.

Oesterreichische Wochenschrift für den Oeffentlichen Baudienst.

THE city of Bruges, the chief town of West Flanders, was as early as the middle of the tenth century one of the largest North European markets. It continued to gain in wealth and importance for about five centuries, until 1435, when political complications and the silting up of the approaches to the harbor began to cause the gradual decline of the prosperity of the town. Schemes were put forward at various times to establish fresh means of communication with the Channel, the North Sea or the Scheldt, but were either ignored or left uncompleted. Between 1870 and 1880, however, a new scheme was drawn up for a ship canal to connect Bruges with the North Sea at Heyst. This scheme was not allowed to drop, and the Belgian Government in the early nineties invited tenders for the work. Instead of Heyst, however, a site situated about midway between Heyst and Blankenberge, and ultimately called Zeebrügge, was finally decided upon as the most suitable place for the outer harbor. Work was begun in 1896 and is now nearing completion. The following details of the harbor works are taken from a recent number of *Oesterreichische Wochenschrift für den Oeffentlichen Baudienst.*

The inland harbor at Bruges consists of three basins. The west is 550 metres long, 63 metres wide at the bottom, 90 at the water line, and 100.6 between tops of banks; the slopes of the banks are protected by loose stone embankments. The east basin, 320 by 90 metres, has brick quays with rubble stone facings. The north basin is 300 metres long and 200 wide and its banks are protected by stone flagging. A hydraulically-operated lock connects the west basin with the canal from Bruges to Ostende. This lock has a total length of 172 metres, the lock chamber being 97.4 metres long and having an opening 12 metres wide and 4 metres deep. The bottom and foundations are of concrete, the side walls of brick work faced with rubble stone. The harbor is equipped with all modern appliances for the rapid loading and discharging of ships.

The ship canal connecting Bruges and Zeebrügge lies in a straight line and has a total length of 10 kilometres. Its width at the bottom is 22 metres, at the water line 70, and 80.6 between tops of banks. The upper part of the slopes of the banks is protected by flagging held in place by a row of piles. On one side the embankment is 53.5 metres wide and on the other 57 metres. On each bank is a tow path 10 metres wide. The normal depth of water in the canal is 8 metres and the banks rise 1.5 metres above the highest water level.

The outer harbor at Zeebrügge is about 100 hectares in area. It is protected from the danger of silting up and from the influence of strong tidal currents by a wall, 2,487 metres long, built in a circular arc. It exhibits four types of construction. At the shore end is a section 232 metres long which lies entirely out of the water at low tide. On a foundation of concrete 10 metres wide and 1 metre thick, contained in a bed formed of sheet piling, is built a masonry retaining wall 3 metres wide. Against the landward side of this wall is placed the main body of the breakwater, consisting of stone packing to a width, at the top, of 11 metres. The inner side of the packing is sloped 1 in 1½, the toe being held in place by sheet piling and the slopes protected by 40 centimetres of masonry set in cement mortar. On the top of the wall, facing the sea, is built a monolithic concrete breastwork and parapet which bring the total height of the breakwater to 11.8 metres above low water mark. The north end of this section of the breakwater, where the trestle work of the second section begins, is formed by a cross wall of masonry on a concrete foundation. This is protected on all sides by stone packing of the same type of construction as described above, but sloping 1 in 3½ and having outside of it 6 metres of fascine work.

To permit of the circulation of currents due to the ebb and flow of the tide and to prevent the silting up of the approaches to the harbor, the next section of the breakwater, 300 metres long, is of steel trestle work. This trestle is 12 metres wide and carries two lines of rails. Each bent consists essentially of six wrought-steel pile piers, the bents being connected by six horizontal girders. At the end of the trestle is an abutment 18 metres long and 5 metres wide to which the breakwater proper is joined.

The breakwater has a total length of 1,955 metres and is built of concrete blocks. The first part, 1,715 metres long, rests on an immense mass of rubble stone. The lower part of the wall, reaching an elevation of one metre above low water, consists of concrete blocks 25 metres long, 7.5 metres wide, and 7 to 9 metres high, and weighing from 3,000 to 4,000 tons. Above this is a wall of Portland cement blocks 5 metres wide and 6.3 metres high and this carries the final course of ten-ton blocks, the width of the top of the wall being 3 metres and its elevation above high water 8.8 metres. The final part of the breakwater is 226 metres long, of similar but heavier construction. A lighthouse is situated at the extreme end.

The space between the breakwater and the quay wall has been gradually filled with sand as the work progressed and when completed the whole pier will be paved. The quay is 1,721.4 metres long and is of the same general type of construction as the breakwater wall. Alongside the quay there is sufficient depth of water to accommodate ships with a draught of 10 or 11 metres.

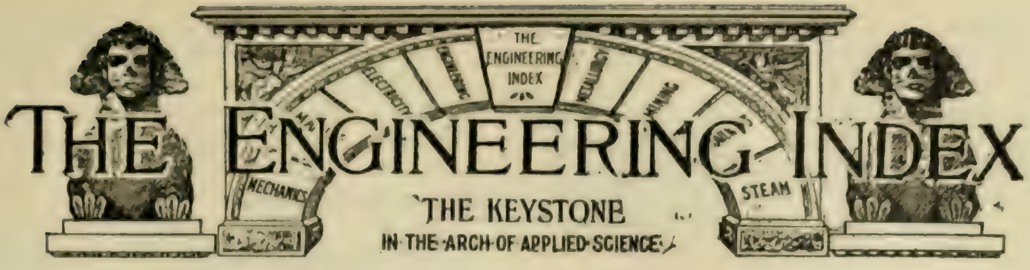
The outer end of the canal, joining the lock with the harbor, is 750 metres long, 50 metres wide at the bottom and 116 at the top of banks, the vertical distance between these points being 13 metres. The slopes are protected below water by fascine work and above by flagging. The lock has a total length of 282 metres and a length between gates of 256 metres. The length of each crown is 62 metres and the width of the opening 20 metres. A portion of the lock, 158 metres long, is widened to form a basin 25.5 metres wide at the bottom and 38 metres between tops of walls. The depth of water in the lock is normally 9 metres and at flood tide 9.5 metres. The excavation for the lock was made in sandy soil. The bottom is of rammed concrete 21.5 metres wide and 3.5 metres thick, laid in a bed formed by strong sheet piling. The walls are built partly of free-stone masonry, partly of rubble-stone masonry, and partly of brick work laid in trass mortar. The lock is crossed by two electrically-operated drawbridges, one of which carries railway and the other vehicular traffic.

The lock gates are of the rolling type and fit into recesses in the crowns. They are trapezoidal in shape and each consists of a steel caisson, 12.7 metres high and 4.5 in breadth, the length at bottom and top being respectively 20.7 and 24.5 metres. The lower part of each gate caisson is at a depth of 5.9 metres below low-water mark, and the top at a height of 6.8 metres above, thus giving for the top of the gates a height of 0.2 metre above the highest spring tides. Each gate is divided longitudinally into two compartments by a horizontal bulkhead. The lower compartment is made water-tight and contains the steadying ballast. The upper compartment is so arranged as to permit the free circulation of water through the gates when such is desirable. The openings are fitted with sliding-valve sluices and with hanging valves. The object of the arrangement is to allow the water level inside the upper compartment, when the gate closes the lock, to correspond always with the higher level without the gate, alternately on the side towards the open sea or on that towards the canal.

The inner side of the lock opens into the inner harbor which is really an enlargement of the canal. This harbor is 60c metres long, 50 metres wide at the bottom, 96.3 at the water line, and 103.5 between the tops of banks. On the east side is a basin 80 by 150 metres for the accommodation of fishing boats. A quarantine basin, also on the east side is large enough to afford turning space for ships of considerable size. On the south side the dry-dock is located. This is 500 metres long and 100 metres wide at the bottom, the slope of the banks being 2 in 1.

The conception of the scheme is entirely that of the contractors, and we may mention at this point that they have not only built the caissons throughout at their Zeebrügge yard, and successfully floated them out—a fact which in itself would suffice to establish their reputation—but they have both designed and built at Zeebrügge the stone-carrier, all the heavy crane parts, both lock-gates above described, the bridges and the gates of the lock in proximity to the Bruges basin, a suction-dredger, the capacity of which is 750 cubic metres (26,490 cubic feet), the floating crane, the Titan crane, and a number of boats. The remainder of the machines and material, including two excavators for the canal, and the tug-boats, have been built by outside firms to save time, but to the contractors' designs.

Though the harbor works are not yet completed, a considerable and rapidly increasing amount of traffic is being handled, according to a note in a recent number of *Engineering*. "From Oct. 1 to Dec. 31, 1906, there entered 161 ships, measuring 88,948 tons, and carrying 106,113 tons; while 156 ships left, carrying 15,486 tons. Of these ships, 139 were British, 7 Dutch, 6 Norwegian, 3 French, 2 Belgian, and 1 each Swedish, Italian, Danish and German. From January 1 to March 31, of the present year, there entered 146 ships, measuring 68,561 tons, carrying 72,994 tons; and there left 148 ships, carrying 14,570 tons. Of these, 113 were British, 13 Dutch, 11 Norwegion, 5 German, 2 Belgian, 1 Russian, and 1 Swedish." It is probable that when the harbor is completed the excellent arrangements and accommodations for ships will draw a very large amount of traffic and that Bruges will regain a great deal of her lost importance as a commercial center.



THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Abutments.

Methods and Cost of Constructing Concrete Abutments for Two Highway Bridges Over the New York State Barge Canal. Emile Low. Gives a general description of the structures and methods of construction, with costs for the Roberts, and Burdick road bridges, near Oneida Lake. Ills. 1700 w. Engng-Con—May 15, 1907. No. 84364.

Anchorages.

Contractor's Plant and Methods for Constructing the New York Anchorages of the Manhattan Bridge. Rearranged from an article by Charles M. Ripley, with additional matter. Explains the methods employed on the New York side of the river. 2500 w. Engng-Con—May 8, 1907. No. 84275.

Arches.

Some Three-Hinged Concrete Arches

in Germany. Illustrates and describes bridges of this type in Bavaria. 900 w. Eng News—May 2, 1907. No. 84042.

The Progress in Building Flat, Solid Arches of Long Spans. Extracts from a paper by Herr Liebbrand discussing especially reinforced-concrete structures with hinged arches. Ills. 2000 w. Cement—May, 1907. Serial. 1st part. No. 84555 C.

Birmingham, Eng.

Smallheath Bridge, Birmingham. Plate and illustrated description of an interesting bridge built in connection with a scheme to connect by a thoroughfare the districts of Smallheath and Sparkbrook, and the southern part of the city of Birmingham. It crosses the Great Western Ry. Co.'s lines, and also a canal. 4500 w. Engng—May 10, 1907. Serial. 1st part. No. 84442 A.

Concrete Arches.

Methods and Cost of Constructing the Connecticut Ave. Concrete Arch Bridge at Washington, D. C. Illustrated description of this structure and the methods of construction, giving details of cost of the materials and work. 2800 w. Engng-Con—May 22, 1907. No. 84535.

The Railway Arches of Concrete at Lautrach and Kempten, Bavaria. Illustrates and describes long span, three-hinge concrete arches without reinforcement, carrying railways, recently built across the Iller, a tributary of the Danube River. 1000 w. Eng Rec—May 11, 1907. No. 84323.

Demolition.

The Temporary Vauxhall Bridge. An illustrated account of the demolition of this structure which has spanned the Thames for the last ten years. 1500 w. Engr, Lond—April 26, 1907. No. 84-258 A.

Erecting Costs.

Cost of Erecting Two Steel Truss Bridges of 180 ft. Span, and One Plate Lattice Girder Bridge of 100 ft. Span. Gives data not including the cost of erecting the false-work. 700 w. Engng-Con—May 8, 1907. No. 84272.

Foundations.

Bridge Foundations of Ferro-Concrete in the River Foyle. Illustrations, with brief description of piers sunk to foundation level by caissons constructed entirely of ferro-concrete. 400 w. Engng—May 10, 1907. No. 84445 A.

Ganges.

The Report of the Ganges Bridge Committee. Report on three alternative bridge schemes for crossing the Ganges River by railways. 1200 w. Engr, Lond—May 17, 1907. No. 84588 A.

Piers.

The Detailed Cost of a Bridge Pneumatic Caisson and Masonry Bridge Pier Data relating to the cost of labor and materials for three railway bridge piers built by the pneumatic caisson process. 2200 w. Engng-Con—May 8, 1907. No. 84274.

Reinforced Concrete.

Special Bridge Structures for the Track Elevation of the Chicago, Burlington & Quincy Ry. in Chicago. Illustrates and describes the construction of a number of street subway bridges having reinforced-concrete deck-girder floor slabs, built in sections at a distance from the site and afterwards set in place. 3500 w. Eng Rec—May 18, 1907. No. 84426.

The Sandy Hill Bridge Over the Hudson River; A Long Reinforced-Concrete Arch Bridge with Block Facing. An illustrated article outlining methods used in the construction of a bridge of 15 equal arches. Good finish, economy and rapid work were secured. 7700 w. Eng News—May 9, 1907. No. 84290.

Steel Arches.

The Design of a Two-Hinged Spandrel-Braced Steel Arch. Ralph Freeman. Explains the methods of calculation and the general principles of the design of a two-hinged arch. 4800 w. Inst of Civ Engrs, No. 563. No. 84457 N.

Bridge Over the River Usk. Illustrated detailed description of a new bridge of pleasing design, near Abergavenny, England. 700 w. Engr, Lond—April 26, 1907. No. 84261 A.

The Oakland Bridge, Pittsburg, Pa.: A Steel Arch Without Hinges. Willis Whited. Illustrates and describes a no-hinge, long-span steel arch viaduct and the method of erection. 2000 w. Eng News—May 16, 1907. No. 84385.

Suspension.

Suspension Bridges. Brief illustrated descriptions of interesting types. 1500 w. Ry & Loc Engng—May, 1907. No. 84030 C.

Viaducts.

Survey Work for a Two-Mile Viaduct, Key West Extension of the Florida East Coast Ry. George P. Carver. An illustrated description of methods employed in locating points and giving lines and grades for piling and concrete forms for nearly 200 piers. 2700 w. Eng News—May 9, 1907. No. 84291.

The Jacksonville Viaduct. A reinforced-concrete structure 845 ft. long and 60 ft. wide, carrying a highway, two street-car tracks, and two sidewalks, is illustrated and described. 1800 w. Eng Rec—May 18, 1907. No. 84428.

CONSTRUCTION.

Anchorages.

The Anchorages of the Singer Building Tower. Illustrates and describes the vertical steel anchorages for the tower, 612 ft. above the curb, built in as the concrete was made, in such a manner as to utilize the full weight of the pier. 1200 w. Eng Rec—May 4, 1907. No. 84221.

Building Details.

Steel Details in the Upper Part of the Singer Building Tower. Illustrated description of dome, beam and floor framing. 1800 w. Eng Rec—May 25, 1907. No. 84567.

Structural Details in the Singer Building, New York. Illustrates and describes details of columns which support the superstructure; also wind bracing details, and other interesting work. 2800 w. Eng Rec—May 18, 1907. No. 84427.

Columns.

Reinforced-Concrete Columns. Gives types of such columns, with notes on the assumptions used in their design, showing what has already been done. 2200 w. Engr, Lond—April 19, 1907. No. 84005 A.

Concrete.

Expansion Joints in Concrete Structures, with Special Reference to Block Construction in Drydocks and Reservoirs. L. F. Bellinger. Explains an approximate method of computing the amount of steel necessary to take up the thermal and shrinkage stresses, giving examples of contraction and expansion, and presents a proposed system of block construction. 5500 w. Eng News—May 2, 1907. No. 84040.

The Commercial Value of Shop Drawings for Concrete Structures. Shows the importance of careful preparation of shop drawings and the setting plans, and their value in saving time and material. 2500 w. Munic Engng—May, 1907. No. 84,-046 C.

Contractor's Plant.

The Contractor's Plant Used in Constructing the Montgomery Ward Building, Chicago. Outlines the conditions under which an 8-story reinforced-concrete building was constructed, in restricted location, illustrating and describing the plant for carrying on the work. 3800 w. Eng Rec—May 11, 1907. No. 84321.

Dam.

A Large Reinforced-Concrete Dam at Ellsworth, Me. Brief description of a dam under construction which has probably the highest head of any structure of this type yet attempted. 1000 w. Eng News--May 23, 1907. No. 84492.

The Dhukwa Dam. Illustrated detailed description of a project for building a dam across the Betwa River in India, giving the interesting features and information of interest. 3000 w. Engr, Lond—May 17, 1907. No. 84585 A.

Demolition.

The Demolition of the Great Wheel. An illustrated account of the methods used in this difficult and interesting engineering work. Plate. 3500 w. Engng —April 26, 1907. No. 84252 A.

Drills.

Well Drills for Blast Holes on the Panama Canal. An illustrated account of work done by the use of well drills, air driven. 1700 w. Compressed Air—May, 1907. No. 84533.

Excavation.

Hydraulic Excavation in Seattle with a Motor-Driven Turbine Pump. George Holmes Moore. Describes the plant used for the reduction of Denny Hill. Ills. 900 w. Eng News—May 16, 1907. No. 84387.

Factories.

An Example of Recent Factory Construction. Robert I. Clegg. Illustrated detailed description of the Automobile Works of the White Co., recently built at Cleveland, Ohio. 2500 w. Ir Age—May 2, 1907. No. 84028.

The New Factory Building of the Murphy Varnish Co. William F. Burleigh. A reinforced concrete building erected at Newark, N. J., of interest because of the unusual style of architecture for factory construction. A mansard roof. 1800 w. Eng Rec—May 4, 1907. No. 84227.

Failures.

Unexpected Accidents (Accidents Inopinés). Paul Sée. Examples of failures of various types of structures, due to causes which could not have been provided for. 3500 w. Mem. d. l. Soc. d. Ing Civ d France—March, 1907. No. 84102 G.

Floors.

Ferro-Concrete Floors at the Waldorf Hotel, Aldwych, London. Illustrates and describes typical sections of these fire-proof floors. 1400 w. Engng—April 19, 1907. No. 84002 A.

Foundations.

Concrete Foundations of the Tallest Skyscraper. Charles M. Ripley. Illustrated description of the methods employed for the Singer Building, the site of which is underlaid with a marshy soil, part quicksand and soft mud. 2500 w. Cement—May, 1907. No. 84556 C.

Perrons.

Foundations for Concrete and Reinforced-Concrete Perrons (Unterbau von Freitreppen in Beton und Eisenbeton). Herr Weidmann. Mathematical discussion of their design and calculation. Ills. 3000 w. Serial. 1st part. Deutsche Bauzeitung—April 24, 1907. No. 84139 D.

Piling.

Methods and Cost of Operating Pile Drivers and Driving Steel Sheet Piling. A paper by William A. Fargo, read before the Mich. Engng. Soc., with additional data on the cost of steel sheet piling work. Ills. 3000 w. Engng-Con—May 1, 1907. No. 84071.

Reclamation Work.

Building a Town Site by Suction Dredge. Day Allen Willey. Illustrated description of interesting work at Cape May, N. J., by which a salt marsh is being filled, giving an area sufficient for 7500 dwellings, in addition to necessary streets. 1500 w. Sci Am—May 25, 1907. No. 84546.

Reinforced Concrete.

Reinforced Concrete Construction. Gunvald Aus. On the necessity of constant inspection of every detail to insure a safe construction, the importance of design, etc. 1600 w. Am Archt—May 4, 1907. Special No. No. 84361 E.

Reinforced Concrete Construction in California. Horatio F. Stoll. A brief review of the concrete work now under way in rebuilding of the districts on the Pacific Coast destroyed by the earthquake and fire. Ills. 2200 w. Cement Age—May, 1907. No. 84554.

Reinforced Concrete in Spain (Le Béton Armé en Espagne). J. E. Ribera. Describes bridges, aqueducts and a siphon of reinforced concrete now under construction. Ill. 5000 w. Mem. d. l. Soc. d. Ing. Civ. d. France. March, 1907. No. 84103 G.

The Coal Pockets of the Salem Mines. A structure of reinforced concrete, of rather unusual character recently built at Alexandria, Pa., is illustrated and described. 1000 w. Eng Rec—May 4, 1907. No. 84226.

Largest Concrete Machine Shop in the World. L. P. Alford. Illustrates and describes the buildings and methods of construction of the new plant of the United Shoe Machinery Co., at Beverly, Mass. 4500 w. Am Mach—Vol. 30. No. 21. No. 84488.

Reinforced-Concrete Construction on the New Building of the Vienna Board of Trade (Eisenbeton-konstruktionen am Neubau der Wiener Handels- und Gewerbekammer). Karl Rössle. A mathematical discussion of the design of this 8-story building. Ills. 1800 w. Beton u Eisen—April, 1907. No. 84186 F.

Roofs.

The New Roof Over Charing Cross Terminal Station, London. Charles S. Lake. A general illustrated description of this new roof, now nearing completion. 1200 w. Eng Rec—May 11, 1907. No. 84325.

San Francisco.

The Effects of the Earthquake and Fire on Steel Structures in San Francisco (Die Wirkungen von Erdbeben und Feuer auf die Eisenkonstruktionen in San Francisco). Prof. Kohnke. Gives the conclusions reached by the writer after personal investigation. Ills. 2700 w. Stahl u Eisen—April 24, 1907. No. 84130 D.

Society Buildings.

The Engineering Societies Building in New York. An illustrated article comparing this new building, its arrangements and facilities, with those of some of the buildings, devoted to similar purposes, in other parts of the world. 2500 w. Cassier's Mag—May, 1907. No. 84048 B.

Structural Engineering.

Some Commercial Features of Structural Engineering. Emil Gerber. Also discussion. Discusses briefly the materials, design, and some details of construction. 8000 w. Pro Engrs' Soc of W Penn—April, 1907. No. 84027 D.

Workmen's Homes.

The Construction of Employees' Homes by German Electric Railways. An illustrated article giving designs and suggestions for homes for workmen, taken from an elaborate work issued by the Prussian Minister of Public Works. 3000 w. St Ry Jour—May 4, 1907. No. 84229.

MATERIALS OF CONSTRUCTION.

Brick.

Sand-Lime Brick. E. W. Smythe. Read before the Wis. Clay Workers' Association. Reviews the history of this material and its use, describing the processes of manufacture used by different workers. 1800 w. Sci Am Sup—May 25, 1907. No. 84548.

Cement.

The Economy of the Long Kiln. E. C. Soper. Gives results of tests on 7' x 60' and 8' x 110' rotary kilns burning natural gas, discussing the kiln question. 1300 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84641 F.

Columns.

Tests of Concrete and Reinforced Concrete Columns; Series of 1906. Arthur N. Talbot. An illustrated account of the materials, test pieces and methods of testing, with experimental data and discussion. 16000 w. Univ of Ills Bul—Feb. 1, 1907. No. 84589 N.

Concrete.

Concrete Walls and Floors. E. P. Goodrich. Discusses some of the points involved in the use of reinforced concrete, especially for walls and floors, explaining some of the characteristics of this material. 4000 w. Am Archt—May 4, 1907. Special No. No. 84360 E.

Concrete Failures. John J. Flather. Briefly considers the causes of failure, discussing the important examples. Ills. 4000 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84632 N.

Notes on Expansion and Contraction of Concrete Structures. A. C. Lewerenz. Observations as to the effect of expansion and contraction on concrete and reinforced concrete and reinforced concrete structures made at a U. S. Navy Yard. Also editorial. Ills. 2400 w. Eng News—May 9, 1907. No. 84295.

The Laws of Proportioning Concrete. Interesting statements presented by Sanford E. Thompson, supplementing a paper read before the Am. Soc. of Civ. Engrs. on April 17. 4000 w. Eng Rec—May 11, 1907. No. 84324.

The Architectural Problem of Concrete. A symposium on the artistic design of reinforced-concrete and concrete structures, giving the opinions of many architects. 13500 w. Am Archt—May 4, 1907. Special No. No. 84358 E.

The Idiomatic Use of Concrete. Evarts Tracy. A brief discussion of the laws governing the use of concrete from the artistic viewpoint. 1200 w. Am Archt—May 4, 1907. Special No. No. 84359 E.

Iron Columns.

Three Tests of Iron Columns (Drei Versuche mit Eisensäulen). Fritz v. Emperger. Flexure tests of columns built up of angles and double T irons. Ills. 2500 w. Beton u Eisen—April, 1907. No. 84187 F.

Plaster.

Process of Producing Bubbleless Plaster. Describes a process of mixing plaster with water so as to exclude all air. 1100 w. Sci Am Sup—May 11, 1907. No. 84331.

Slaking a Plaster and Means of Retarding Its Hardening. Gives hints from practice. 1500 w. Sci Am Sup—May 11, 1907. No. 84329.

Reinforced Concrete.

Engineering Advice as to Reinforced Concrete. Report of the Committee on Architecture, Illinois Society of Engineers and Surveyors. 2000 w. Am Archt May 4, 1907. Special No. No. 84362 E.

Reinforced Concrete: Its Limitations. Carl Gayler. A discussion of this material, the effects of shrinkage, details of construction, etc. Ills. 5000 w. Jour of Engng Socs—April, 1907. No. 84527 C.

Reinforced-Concrete Structures for Manufacturing Purposes. Leonard C. Wason. An illustrated article presenting the advantages of this material and its economy. 2500 w. Engineering Magazine—June, 1907. No. 84195 B.

Experiments on the Effects of Stress in Reinforced-Concrete Beams (Versuche über die Schubwirkungen bei Eisenbetonträgern). Emil Mörsch. Paper read before the Deutscher Beton-Vereins, describing the results of elaborate experiments to determine the way in which reinforced-concrete beams usually fail. Ills. 7000 w. Serial, 3 parts. Deutsche Bauzeitung—April 13, 20, May 1, 1907. No. 84138 each D.

Timber.

Methods and Economic Aspects of Modern Timber Preservation. Gellert Alleman. Gives statistics of the amount of timber used in a year, and the per cent. treated; describes briefly the methods of treatment, the life and cost, discussing economic considerations, injury caused by treatment, etc. Discussion. Ills. 10500 w. Pro Engrs' Club of Philadelphia—April, 1907. No. 84525 D.

Preservation of Mine Timber from Decay. John M. Nelson. Reviews experimental work conducted by the Philadelphia & Reading C. & I. Co., and U. S. Fōrest Service, showing how the life of timber may be prolonged. Ills. 1000 w. Eng & Min Jour—May 4, 1907. No. 84213.

The Powell Process of Preserving Wood with Saccharine. Illustrated description of this process which is simple, inexpensive and said to be efficient. 2200 w. Sci Am Sup—May 11, 1907. No. 84333.

The Preservation of Woods by the New Methods of Impregnation (La Conservation des Bois par les Nouvelles Méthodes d'Imprégnation). E. Lemaire. Discusses the causes of the decay of wood and the natural and artificial methods used to preserve it; describing principally the impregnation processes and the effects of the chemicals used in them. 5000 w. Génie Civil—April 13, 1907. No. 84113 D.

The Preservation of Railway Ties (La Conservation des Traverses de Chemins de Fer). A summary of the results of experiments on the heat-conducting qualities of wood with a view to determining the value of raising the wood to high temperatures before impregnation with preservative solutions. 3000 w. Génie Civil—April 27, 1907. No. 84118 D.

MEASUREMENT.

Surveying.

Methods of Surveying on New York State Roads. Information from a manual issued by Henry A. Van Alstyne concerning the methods used. 2500 w. Eng Rec—May 25, 1907. No. 84566.

MUNICIPAL.

Fire Apparatus.

Fire Prevention Apparatus. John

Richards. Suggests a fire boat or barge provided with units of rotative pumping apparatus, and other features. With special reference to San Francisco and its needs. Discussion. 3500 w. Jour Assn of Engng Socs—April, 1907. No. 84528 C.

Garbage.

Two Years' Operations of the Municipal Garbage Reduction Works, Cleveland, O. Gives figures on the cost of garbage collection and disposal. 4000 w. Eng News—May 2, 1907. No. 84044

Harbor Pollution.

The Pollution of New York Harbor. George C. Whipple. Map and explanation of present conditions, with a study of important phases of sewage disposal at New York. 5400 w. Eng News—May 23, 1907. No. 84499.

Pavements.

Modern Methods in Cement Paving. H. L. Weber. Read before the Assn. of Am. Cement Mfrs. Gives details and cost data in the construction of streets and sidewalks with concrete foundations. Specifications and letters are given. 5000 w. Cement Age—May, 1907. No. 84553.

The Maintenance of Asphalt Pavements. S. Whinery. Discusses the most economical method of keeping asphalt pavement in repair. 5000 w. Eng News —May 9, 1907. No. 84294.

Public Health.

Public Health and the Future of Paris (Santé Publique et Paris de Demain). Gaston Trélat. Paper read at the convention of the National Academy of Arts and Crafts. Discusses the sources of danger to public health and the problems which confront Paris. Ill. 8000 w. Rev Gen des Sci—April 15, 1907. No. 84109 G.

Roads.

Methods and Cost of Constructing and Maintaining Oyster-Shell Roads. Josiah Miller. Information relating to the construction and maintenance of shell roads and the cost. 2200 w. Engng-Con—May 1, 1907. No. 84070.

Methods and Cost of Tarring Macadam and Clay Roads in South Haven, Mich. Charles R. Wrightman. Describes methods and gives suggestions based on experience. 1500 w. Engng-Con—May 8, 1907. No. 84273.

Some Notes on Tractive Force on Roads. Discusses results of experimental tests. 2500 w. Prac Engr—May 10, 1907. No. 84436 A.

Septic Tanks.

Recent Septic Tanks. Illustrated descriptions of reinforced-concrete plants at Newton, N. J., and at Belleville. Ills. 1000 w. Munic Jour & Engr—May 1, 1907. No. 84034 C.

On the Question of the Importance of Septic Tanks for Biological Water Purification (Zur Frage von der Bedeutung des Septiktanks für die biologische Abwasserreinigung). Dr. S. K. Dzierzgowsky. The first part of the serial gives several tables of elaborate records of the action of septic tanks in water purification made from tests at Tsarskoje Sselo. Ills. 16500 w. Serial. 1st part. Gesundheits Ing.—April 27, 1907. No. 84185 D.

Sewage.

A Description of the Recently Installed Sewage Disposal Works for the Village of Balliston Spa, New York. G. L. Robinson. Detailed description with illustrations and explanation of the character of the sewage. 2800 w. Pro Am Soc of Civ Engrs—May, 1907. No. 84561 E.

The Admission of Trade Wastes into Sewers of Reading, Pa. An account of an investigation made and the conclusions reached, describing the character of the wastes and giving the classification made. 2200 w. Eng Rec—May 25, 1907. No. 84564.

Sewerage Construction Work. Describes some of the machinery being adopted for this work. Excavators, conveyors, etc. Ills. 2500 w. Munic Jour & Engr—May 1, 1907. No. 84032 C.

Sewerage Pumps and Lifts. Illustrates and describes centrifugal pumps, ejectors, and lifts. 3300 w. Munic Jour & Engr —May 1, 1907. No. 84033 C.

Sewers.

Method of Constructing a 6-ft. Sewer Siphon Under a 16-ft. Conduit, Chicago, Ill. Illustrates and describes an interesting piece of work executed recently in connection with the construction of the Intercepting Sewer System. 700 w. Engng-Con—May 22, 1907. No. 84536.

Reinforced Concrete Sewers and Conduits, in the United States of America. Ernest Romney Matthews. Illustrates and describes a number of sewers and conduits which have been constructed on this principle in American cities. 3800 w. Inst of Civ Engrs, No. 3645—No. 84459 N.

Street Cleaning.

Street Cleaning in the Central Business District of Chicago. An illustrated article explaining the work done by the Citizens' Street Cleaning Bureau, and stating the conditions and cost. 4800 w. Eng Rec—May 25, 1907. No. 84565.

WATER SUPPLY.

Albany, N. Y.

Improvements to the Water Supply System of Albany, N. Y. Information in regard to the new filter plant and increase in capacity of the Quackenbush St. pumping station. Ills. 1200 w. Eng Rec—May 18, 1907. No. 84430.

Aqueduct.

Repairing a Limestone Concrete Aqueduct. Michael Ratcliffe Barnett. An account of the leakage in the Thirlmere aqueduct, which conveys water to Manchester, Eng., due to deterioration of the concrete, resulting from the action of water on the limestone with which the concrete was made. Ills. 7500 w. Inst of Civ Engrs, No. 3636—No. 84466 N.

Drainage-Areas.

The Yield of Catchment-Areas. Ernest Prescot Hill. Suggests a system of observations to obtain information upon which the design of water-works can be based. 2200 w. Inst of Civ Engrs, No. 3641—No. 84467 N.

Edinburgh.

The Talla Water-Supply of the Edinburgh and District Water-Works. William Archer Porter Tait. An account of this scheme and its execution, which increases the supply at a cost of £1,250,000. 15000 w. Inst of Civ Engrs, No. 3611—No. 84465 N.

Filtration.

Notes on Water Filtration in Japanese Cities. George A. Johnson. Notes on the Tokyo water-works, and the Osaka works, with illustrations. 4000 w. Eng Rec—May 11, 1907. No. 84318.

Operation of the New Haven Water Co.'s Filter Plant. Charles A. Ferry. Read before the Conn. Soc. of Engrs. Reports the operation of the Whitneyville filtration plant which supplies about 8,500,000 gals. per day. 3000 w. Eng News—May 9, 1907. No. 84293.

Sand Filters at Bar Harbor, Me., and South Norwalk, Conn., for the Removal of Organisms, Tastes and Odors from Water. H. W. Clark. Brief illustrated descriptions of these filters. 1600 w. Eng News—May 23, 1907. No. 84493.

The American System of Filtration Plant at Damietta, Egypt. Edmund B. Weston. Outlines the history of this town, and briefly describes its former water-works, giving an illustrated description of the new plant. 2500 w. Eng Rec—May 4, 1907. No. 84220.

Hong Kong.

The Tytam Tuk Water-Works, Hong Kong. D. Jaffé. Illustrated description of new works in progress to increase the water supply. The new reservoir is 200 ft. below the level of the inlet to the tunnel of the original works, and the water is pumped. 1800 w. Eng Rec—May 25, 1907. No. 84562.

Irrigation.

Egyptian Irrigation and the Assuan Dam. Information contained in a recent despatch from Lord Cromer concerning the benefits this reservoir has conferred on Egypt, and matters related. 2500 w. Engr, Lond—April 26, 1907. No. 84260 A.

Koeta Radja.

The Procuring of Pure Water at Koeta Radja (De Drinkwatervoorziening van Koeto Radja). H. Heetjans. Illustrated description of the project, tunnel, canal, etc. 7000 w. De Ingenieur—April 13, 1907. No. 84190 D.

New York City.

Progress on New York City's Catskill Water Supply System: Dams of the Ashokan Reservoir. Map, illustrations and outline of the plans for increasing the supply by 500,000,000 gals. per day. 1000 w. Eng News—May 9, 1907. No. 84296.

Pipe Lines.

On a More Economical Profile for Pressure Conduits of Iron or Steel Plates (Sul Profilo piu Economico delle Condotte Forzate in Lamiera di Ferro o d'Acciaio). A. Anastasi. Mathematical Paper. Plate. 7000 w. Ami della Soc Ing e d Arch Ital—Vol. XXI, No. 3. No. 84127 F.

Pipe Sizes.

A Solution of the Problem of Determining the Economic Size of Pipe for High-Pressure Water-Power Installation. Arthur L. Adams. Gives a solution worked out by the author stating the assumptions upon which it is based. 900 w. Pro Am Soc of Civ Engrs—May, 1907. No. 84560 E.

Graphic Methods of Calculating Conduits for Gas, Air, and Water (Abaques pour le Calcul des Conduites de Gaz, d'Air et d'Eau). A. Grebel. Mathematical explanation of the methods illustrated by examples. Ills. 2500 w. Génie Civil—April 13, 1907. No. 84114 D.

Pumping-Station.

A Rock-Cut Bomb-Proof Pumping Station at Gibraltar. Albert Wilson. Describes a station built to make secure, in time of war, the supply of water for sanitary and domestic use. 1500 w. Inst of Civ Engrs, No. 3528—No. 84460 N.

Reservoirs.

New Reservoirs at Walton. Leading particulars, with illustrations, of two large reservoirs under construction on the south side of the Thames. 1600 w. Engr, Lond—April 19, 1907. No. 84007 A.

Run-Off.

Comparison Between Rainfall and Run-off in the Northeastern United States. John C. Hoyt. A study based on information collected by the U. S. Government, and by private parties, in regard to precipitation and stream run-off. Tables and map. 2500 w. Pro Am Soc of Civ Engrs—May, 1907. No. 84559 E.

Rust.

Rust in Water Pipe Lines and Means of Prevention (Rost in Wasserleitungen, Schutz- und Vorbeugungsmittel). H. Wehner. The first part discusses the agencies which cause rusting of iron pipes and the effect of atmospheric conditions. Ills. 11000 w. Serial. 1st part. Gesundheits Ing—April 20, 1907. No. 84184 D.

Sluice.

Automatic Sluice in the Bondman Weir Across the Aire at Leeds. Illustrated description of this work executed in connection with sanitary measures on the River Aire. 1400 w. Engng—May 17, 1907. No. 84579 A.

Treatment.

Experiments on the Preliminary Treatment of Water at Washington, D. C. A report of experiments being carried on by the engineers of the filtration plant, which is of the slow-sand type. 2000 w. Eng Rec—May 25, 1907. No. 84568.

Water Supply.

Discussion on Water Supply. Discussion of papers by Messrs. Tait, Barnett, and Hill. 31000 w. Inst Civ Engrs—Nov. 27, and Dec. 11, 1906. No. 84468 N.

Water-Works.

Water-Works Constructions in America. Ernest Romney Matthews. Detailed description of American methods of design and construction of such works. Ills. 4500 w. Soc of Engrs—May 6, 1907. No. 84485 N.

The New Water-Works at Wilmington, Del. An illustrated article describing the new reservoir, and slow-sand filters, new pumping plant, force and distribution mains, and the reinforced-concrete Van Buren St. bridge. 3800 w. Eng Rec—May 4, 1907. No. 84225.

WATERWAYS AND HARBORS.

Breakwater.

The Stone Breakwater at Cleveland, O. George H. Cushing. Illustrates and describes a modification in the form of construction of the stone masonry portion of the breakwater, as recommended by Lt.-Col. Curtis McD. Townsend. 1500 w. Eng News—May 23, 1907. No. 84496.

Canals.

The Kaiser Wilhelm Canal. Describes briefly the methods proposed to increase the efficiency of this canal, stating the existing conditions. 1200 w. Engr, Lond —May 3, 1907. No. 84346 A.

Coast Protection.

The Protection of Sea Shores from Erosion. Alfred Edward Carey. Gives examples of the magnitude of wave force, with description of the coasts of the British Isles and the methods of protecting them, and offering suggestions. General discussion. Ills. 12500 w. Jour Soc of Arts—May 3, 1907. No. 84334 A.

Derrick.

A Floating Derrick for Handling Heavy Rip-Rap Stone. Illustrated description of a floating derrick and grapple specially designed for the harbor work at Superior Entry, Wis. 1200 w. Eng News—May 23, 1907. No. 84494.

Docks.

The Rothesay Dock at Glasgow. An illustrated description of the construction and equipment of this new dock, electricity having been adopted as the motive power. The dock was built to relieve the congestion of traffic at the mineral quays. 5400 w. Engng—April 26, 1907. No. 84253 A.

Levee.

The Construction of the Levee Below the Recent Colorado River Break. C. W. Ozias. Describes the soil and general conditions and gives an illustrated description of the methods of levee construction. 1800 w. Eng News—May 16, 1907. No. 84389.

Madoera.

Report on the Improvement Work at the West Opening of the Strait of Madoera (Bescheiden Betreffende de Verbetering van het Westgat van Straat Madoera). H. Wakkie. 12000 w. De Ingenieur—April 27, 1907. No. 84189 D.

North Sea.

The North Sea: Its Physical Characteristics, Tides and Currents. W. H. Wheeler. Map and information in regard to the dimensions, coast line, and general formation. 3500 w. Engr, Lond —May 17, 1907. No. 84582 A.

Piers.

Cement Piers. Illustrates and describes the cement cylinder piers used for dock construction at San Francisco, and on the Pacific coast, stating the methods of construction. 600 w. Sci Am Sup—May 25, 1907. No. 84550.

The Collapse of the Locust Point Pier, Baltimore. An illustrated account of the collapse of a pier in an advanced stage of construction. 1200 w. Eng Rec—May 11, 1907. No. 84319.

Salton Sea.

The Colorado River Closure. W. D. H. Washington. An account of the cause of the breach which caused the flooding of the Salton Sink, and of the methods tried in effecting a closure. Ills. 3000 w. Sci Am—May 4, 1907. No. 84081.

MISCELLANY.

Address.

Presidential Address of Sir Alexander B. W. Kennedy. On the engineer, his relation to science, art, nature, law, commercial, professional and industrial life, etc. 11000 w. Inst of Civ Engrs—Nov. 6, 1906. No. 84470 N.

Asbestos Wood.

New Fire Retardant. Prof. Charles L. Norton. Describes tests made of asbestos wood, a non-inflammable material that can be worked with ordinary tools. Ills. 2200 w. Ins Engng—April, 1907. No. 83957 C.

Dam.

The San Roque Dam (Dique de San Roque). Daniel E. Gavier. Report of an investigation of the condition of stability of this dam in the Argentine Republic. Ill. 4500 w. Serial. 1st part. La Ingeneria—Feb. 28, 1907. No. 83996 D.

Earth Slip.

Earth Slip at the Viaduct of the Gor, Spain (Glissemeut de Terrain au Viaduc du Gor, Espagne). Arsène Portier. A description of the causes and effects of earth-slip under one of the abutments of a bridge between Grenada and Murcie, Spain. Ill. 4000 w. Mem. d. l. Soc. d. Ing. Civ. l. France—March, 1907. No. 84104 G.

English Channel.

Channel Tunnels, Bridges and Ferries. Reviews the various projects for constructing a tunnel under the Straits of Dover, for the laying of submerged tubes and roadways for ferries carrying the trains, and for bridges across the Channel. Also editorial. 5000 w. Engr, Lond—March 22, 1907. No. 83427 A.

Hauling Crops.

Costs of Hauling Crops from Farms to Shipping Points. Frank Andrews. Condensed from Bul. 49, Bureau of Statistics, U. S. Dept. of Agri. Information obtained through inquiries sent out. Editorial discussion. 4800 w. Eng News—April 18, 1907. No. 83892.

Ideals.

Professional Ideals of the Twentieth Century. Address of President Hadley of Yale University at the dedication of the Engineering Societies Building in New York. 3000 w. Eng Rec—April 20, 1907. No. 83834.

Rainfall.

Salton Sea and the Rainfall of the Southwest. Alfred J. Henry. An examination of the conditions showing it to be very doubtful that any local evaporation increases the rainfall. 2200 w. Nat Geog Mag—April, 1907. No. 83854 C.

Reclamation.

Reclaiming the Swamp Lands of the United States. Herbert M. Wilson. An interesting account of the many swamps in the United States, what has been done in draining them, and work proposed. Ills. 4000 w. Nat Geog Mag—May, 1907. No. 84455 C.

Roof Collapse.

The Collapse of Concrete Roof Arches at the Lawrence Filter. John F. O'Connell. An illustrated account of the recent collapse of the groined concrete roof arches, thought to be due to the action of frost before the concrete had set. Also editorial. 2500 w. Eng Rec—April 27, 1907. No. 83947.

Tin Roofs.

Fire Resistance of Tin Roofing. Edwin L. Seabrook. A study of its fire-protecting qualities giving instances where it prevented the fire from spreading. Ills. 1500 w. Ins Engng—April, 1907. No. 83958 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Steno-Telegraphy. A descriptive account of a new development intended to effect a degree of economy and efficiency in submarine cable transmission. 2500 w. Elect'n, Lond—May 10, 1907. No. 84439 A.

Dictating Machine.

Telephone Dictating Apparatus. Describes a recently invented telephone dictating machine by which a person may dictate to any one of his stenographers without requiring them to leave their desk. Ills. 1200 w. Sci Am Sup—May 11, 1907. No. 84330.

Electric Waves.

The Silicon Detector, and Measurement of Electric Wave Energy. William Meaver, Jr. Describes the Pickard detector, which is of the thermo-electric type of wireless receivers, and tests made with it. 900 w. Sci Am Sup—May 25, 1907. No. 84547.

Poles.

The Sterilization and Preservation of Telephone and Telegraph Poles. H. P. Folsom. Abstract of an address before the Ohio Ind. Tel. Assn. Gives an estimate of the number of poles used in the United States, and their value, discussing the cause of decay and the remedy. 1500 w. Elec Rev, N Y—May 4, 1907. No. 84097.

Radiotelegraphy.

A Military Wireless Telegraph Equipment. A. Frederick Collins. Illustrates and describes the various kinds of field equipment and the arrangements for transporting it. 1200 w. Sci Am—May 4, 1907. No. 84080.

A New Government Portable Wireless Telegraph Apparatus. R. H. White. Illustrated detailed description of an outfit that can be carried on the backs of three mules. 2000 w. Elec Rev, N Y—May 25, 1907. No. 84606.

Automatic Calling Device for a Wireless Telegraph System. W. R. Carroll. Describes the equipment of the station at Yerba Buena Island, San Francisco Bay, especially the auto-sender and its operation. 1000 w. Elec Wld—May 25, 1907. No. 84610.

Telegraphy.

The Rowland Telegraphic System. Louis M. Potts. Describes a system which provides for an increased wire capacity, combined with greater efficiency of the operator and adaptability to present-day requirements. It combines multiplexing and printing. Ills. 8800 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84511 D.

Telephony.

Fleet Telephony. Bradley A. Fiske. Explains a scheme for maintaining communication by telephone between the various vessels during fog. 1400 w. Pro U S Nav Inst—March, 1907. No. 84025 F.

Telephonic Transmission Measurements. B. S. Cohen. Describes results obtained in the investigation laboratory of the National Telephone Co., which include methods of measuring frequency, distortion, attenuation, current and power of telephone waves, and also line and instrument impedances. 5500 w. Inst of Elec Engrs—May 9, 1907. No. 84480 N.

The Home Telephone Company, Ironton, Ohio. Illustrated detailed description of a new automatic central energy system. 3000 w. Elec Rev, N Y—May 4, 1907. No. 84098.

Telephotography.

The Electrical Transmission of Pictures (La Transmission Electrique des Images). M. Henry. A review of the researches on the subject leading up to descriptions of the work of Fowler and Korn. Ill. Serial. 1st part. 3500 w. L'Elec'n—April 20, 1907. No. 84106 D.

DISTRIBUTION.

Compensators.

Direct Current Compensators for Balancing Electric Circuits. H. M. Biebel. Describes a device whereby one or more neutral wires can be introduced into a two-wire circuit, making it possible to obtain circuits of proportional lower voltage. Ills. Discussion. 5000 w. Jour W Soc of Engrs—April, 1907. No. 84532 D.

Conductors.

Drawing Conductors into Conduit. T. W. Poppe. Describes methods used in drawing in conductors after the conduit work is complete. 1200 w. Elec Wld—May 4, 1907. No. 84207.

Economical Conductor Section. Frank G. Baum. Discusses the method of determining the most economical size of conductor for a certain case. Considers the value of Kelvin's law. Also editorial. 2500 w. Elec Wld—May 25, 1907. No. 84608.

"Flexibles."

"Flexibles," with Notes on the Testing of Rubber. Prof. Alfred Schwartz. Discusses fire risks from flexibles, conductors, heating due to excessive currents, insulation, oxidation of rubber, effect of high temperature, tests, flexible wiring system, etc. 19000 w. Inst of Elec Engrs —April 18, 1907. No. 84010 N.

French Legislation.

French Legislation on Electric Distribution. Editorial on legislation dealing with distribution within the limits of private properties, and transmission along and across public thoroughfares. 1500 w. Engng—April 26, 1907. No. 84256 A.

Fuses.

Theoretical and Practical Points in Connection with Safety Fuses (Theoretisches und Praktisches über Abschmelzsicherungen). Georg J. Meyer. The first instalment gives a mathematical discussion of fuses and considers various materials from which fuses may be made giving results of tests. Ills. 4000 w. Serial. 1st part. Elektrotech Zeitschr—April 25, 1907. No. 84174 D.

Transformers.

Forced-Oil and Forced-Water Circulation for Cooling Oil-Insulated Transformers. C. C. Chesney. Short paper introductory to a discussion. 500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84515 D.

Relative Advantages of One-Phase and Three-Phase Transformers. John S. Peck. Considers the various advantages and disadvantages of a three-phase transformer as compared with a group of three one-phase transformers whose aggregate output is the same. Introductory to a discussion. 1600 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84514 D.

Relative Merits of Three-Phase and One-Phase Transformers. H. W. Tobey. Short paper to introduce discussion, outlining the two systems and pointing out the advantages and limitations of each. 800 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84513 D.

Wiring.

Enclosed Station Wiring. F. O. Blackwell. Introduction to a discussion. Gives photographs showing high-potential arcs 500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84516 D.

DYNAMOS AND MOTORS.

Alternating Current.

The Alternating-Current, Compound-Wound Motor of the Felten & Guilleaume-Lahmeyer Works (Die Wechselstrom-Doppelschluss-Motor der Felten & Guilleaume-Lahmeyerwerke). M. Osnos. Illustrated detailed description of this type of motor, explaining its great value for hoisting purposes. 7000 w. Two articles. Elektrotech Zeitschr—April 11 and 18, 1907. No. 84172 each D.

Direct-Current.

Notes on the Characteristic Curves of the Direct-Current Machine. Harrison W. Smith. Notes found useful in discussing the action of the direct-current machine. 3000 w. Tech Qr—March, 1907. No. 84474 E.

Inductive Motors.

The Induction Motor. C. J. Spencer. A discussion of the induction motor, the functions of the secondary, and methods of calculating the resistance, and related matters. 2800 w. Elec Age—May, 1907. Serial. 1st part. No. 84621 C.

Protection.

Protection of Motors in Dusty Places. Kingsley Williams. Illustrates and describes various methods of housing and ventilating motors. 800 w. Elec Wld—May 4, 1907. No. 84208.

Two-Pole.

Two-pole A. C. Machines with Constant and Separately Excited Fields, a Contribution to the Construction of Turbo-generators (Zweipolige Wechselstrom-Maschinen mit feststehendem Felde und verketteter Erregermaschine, ein Beitrag zum Bau der Turbodynamos). A. Heyland. Theoretical and mathematical discussion of their design. Ills. 5000 w. Elektrotech Zeitschr—April 11, 1907. No. 84170 D.

Variable Speed.

A New Variable Speed Motor. Benjamin F. Bailey. Describes a simple method by which either all or one-half of the armature conductors can be connected, thus giving two normal speeds, one twice as great as the other. Also editorial. 2500 w. Elec Wld—May 11, 1907. No. 84311.

ELECTRO-CHEMISTRY.

Electro-Metallurgy.

The Electrometallurgical Industries in 1907. John B. C. Kershaw. Reviews the progress of these industries during the past year, and their position at the present time. Ills. 4500 w. Cassier's Mag—May, 1907. No. 84049 B.

Electrolytic Lead Refining and Treatment of Slimes and By-Products. A. G. Wolf. Explains the theory and practice of lead refining by the Betts process, describing a plant and the process of testing the slimes, and all by-products. 1300 w. Min Rept—May 9, 1907. Serial. 1st part. No. 84304.

Electroplating.

Recovering Silver from Cyanide Solutions. Describes the recovery by precipitation and by evaporation, stating the dangers of the first, and illustrating an evaporating furnace. 1000 w. Brass Wld—May, 1907. No. 84453.

ELECTRO PHYSICS.

Batteries.

An Electrical Method of Depolarizing Primary Batteries. Frank W. Springer. Describes an invention relating to the improvement of systems for the supply of current in which primary cells or batteries are employed, especially the improvement of ignition systems of explosive engines. 2000 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84629 N.

Dielectrics.

On the Loss of Energy in Dielectric Substances in Condensers and Cables (Ueber den Energieverlust im Dielektrikum von Kondensatoren und Kabeln). Bruno Monasch. Methods and results of experimental determination for various substances. Ills. 9500 w. Serial. 2 parts. Elektrotech u Maschinenbau—April 21 and 28, 1907. No. 84156 each D.

Lightning.

New Principles in the Design of Lightning Arresters. E. E. F. Creighton. The first of two papers discussing the new features of a new multigap arrester. Ills. 4000 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84510 D.

Protection Against Lightning, and the Multigap Lightning Arrester. David B. Rushmore and D. Dubois. On the most recent developments in the multigap lightning arrester, giving recommendations concerning the protection of transmission lines and electrical apparatus from lightning disturbances. Ills. 7000 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84509 D.

GENERATING STATIONS.

Central Plants.

Recent Developments in Large Central Electric Plants. Thomas C. McBride. A review of progress dealing only with the more important details, especially with those that aim at lessening the cost of production and distribution. General discussion. 11000 w. Pro Engrs' Club of Phila—April, 1907. No. 84523 D.

Commutation.

Problems in Commutation. Miles Walker. Discusses some of the causes of bad commutation. 3500 w. Elec Jour—May, 1907. No. 84477.

Direct-Current.

Parallel Operation of Direct-Current Generators. J. C. Hail. Considers shunt-wound generators connected in parallel, and compound wound generators in parallel operation. Diagrams. 2000 w. Elec Age—May, 1907. No. 84622 C.

Exciters.

Exciter Troubles. A. E. Buchenberg. Diagram and general discussion of the difficulties and troubles which may arise in the operation of direct-current machines when used as exciters for alternators. 3000 w. Elec Wld—May 4, 1907. No. 84206.

Germany.

Statistics of Electric Power Plants in Germany (Statistik der Elektrizitätswerke in Deutschland). Gives the essential details of over 1,600 electric power plants, either in operation or under construction, location, purpose, motive power, machines, capacity, etc. 75000 w. Elektrotech Zeitschr—April 18, 1907. No. 84173 D.

Hydro-Electric.

Notes on Hydro-electric Plant Organization and Operation. Farley Osgood. Discusses the hydraulic power-station, and line departments and the organization of the personnel of an operating system. 8500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84512 D.

Power Development on the Kootenay River for the West Kootenay Power & Light Company, Limited. Robert A. Ross and Henry Holgate. Illustrated description of a power development at Upper Bonnington Falls, British Columbia. 3500 w. Can Soc of Civ Engrs—May 9, 1907. No. 84396 N.

The Huronian Company's Power Development. Robert A. Ross and Henry Holgate. Illustrated description of the development at High Falls, on the Spanish River, to furnish power for the nickel and copper mines of the Sudbury District. 6000 w. Can Soc of Civ Engrs—April 25, 1907. No. 84395 N.

The Great Falls Station of the Southern Power Co. Curtis A. Mees and John H. Roddey. Part I gives an illustrated description of the natural power and the hydraulic features of the development. 5000 w. Eng Rec—May 18, 1907. Serial. 1st part. No. 84425.

The St. Croix Falls Power Plant. Wadsworth A. Williams. Illustrated description of the water-power development on the St. Croix River, which transmits current for power and light to Minneapolis, 40 miles distant. 1800 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84633 N.

Tyrol Hydro-Electric Power Station, Keiserwerke. Illustrates and describes an installation for supplying power for industrial and lighting purposes in the northern part of Tyrol. 1700 w. Elec Wld—May 11, 1907. No. 84310.

The Cazadero Generating Station of the Portland Railway Light & Power Company. An illustrated description of an interesting installation in Oregon, comprising a dam across the Clackamas river, a flume and waterway 1.7 miles long, the generating station and a step-up transformer station. 1100 w. Elec Ry Rev—May 11, 1907. No. 84279.

Water-Power Development at Kardaun near Bozen (Wasserkraftanlage Kardaun bei Bozen). Andreas Stamm. Illustrated detailed description of dam, pipe-line, power house, turbines, generators, etc., at this plant in the Tyrol. 3000 w. Serial. 2 parts. Zeitschr f d Gesamte Turbinenwesen—April 10 and 20, 1907. No. 84157 each D.

The Pöls Power Plant (Die Pölswerke). Philipp Ehrlich. Illustrated description of an Austrian hydro-electric power plant generating 1,100 horse power. 2000 w. Zeitschr d Oest Ing u Arch Ver—April 26, 1907. No. 84180 D.

Lightning Arresters.

See Electrical Engineering, Electro-Physics.

Operation.

Suggestions for the Power House Operator. Arthur B. Weeks. Remarks on the importance of self-control in emergencies, and of originality and thorough understanding of the apparatus. 1000 w. Elec Wld—May 4, 1907. No. 84210.

Power Stations.

The New Turbine Power Station of the Dallas Electric Corporation. Illustrated detailed description. 2500 w. St Ry Jour—May 18, 1907. No. 84371.

The Kent Electric Power Company. Illustrates and describes the generating plant of this company, at Frindsbury. 1500 w. Elect'n, Lond—May, 1907. Serial. 1st part. No. 84438 A.

A Most Economical System for Generation of Current. Illustrates and describes a reconstructed station at Lockport, N. Y., where a system of underground steam heating is installed, which utilizes all the heat in exhaust steam and most of that in the flue gases. 2200 w. Engr, U S A—May 15, 1907. No. 84404 C.

Regulation.

Balancers. William H. Taylor. Gives diagrams showing the arrangements of connections for balancers, and discussing their defects. 700 w. Elec Rev, Lond—May 10, 1907. No. 84437 A.

Rome.

Progress on Rome's Municipal Electric Plant (Progretto per l'Impianto Elettrico Comunali di Roma). G. Giorgi. A description of the plant with plates showing the construction of the buildings, the arrangement of machines, etc. 9000 w. Boll della Soc d Ing e d Arch Ital—April 15, 1907. No. 84123 F.

The Municipal Electrical Installation of Rome. Trans. from *L'Ing. Ferroviaria.* Particulars in regard to a proposed municipal electrical undertaking for lighting and power at Rome, Italy. Ills. 1200 w. Elec Rev, Lond—May 17, 1907. No. 84575 A.

Wind Power.

Wind Power for the Generation of Electricity. W. O. Horsnaill. Considers the possibility of utilizing wind power for the electric lighting of country houses and gives an account of actual installations. 2000 w. Elect'n, Lond—May 3, 1907. Serial. 1st part. No. 84337 A.

LIGHTING.

Costs.

A Comparative Study of Lighting Costs and Related Matters (Vergleichende Betrachtungen über Beleuchtungskosten und Einschlägiges). August Marussig. The first instalment of the serial gives the mathematics of illumination and discusses the lighting power of various illuminants. Diagrams. 5000 w. Serial. 1st part. Oest Wochenschr f d Oeff Baudienst—April 13, 1907. No. 84178 D.

Frosted Lamps.

A Brief Theory of the Reduction in the Service Life of Frosted Incandescent Lamps. Dr. A. E. Kennelly. Outlines a quantitative theory deriving formulæ which serve to explain the results obtained by Preston S. Millar. 1600 w. Elec Wld—May 18, 1907. No. 84416.

Incandescent Lamps.

Economic Considerations in the Use of Metallic-Filament Incandescent Lamps (Considerazioni Economiche sull' Uso di Lampade Incandescenti a Filamento Metallico). D. Civita. Mathematical and descriptive paper. 3000 w. Elettricitá—April 12, 1907. No. 84120 D.

On the Temperature and Illuminating Properties of Carbon, Osmium and Tungsten (Ueber Temperatur und Lichtemission von Kohle, Osmium und Wolfram). A. Grau. Results and comparison of tests of lamps with filaments of these substances. Ills. 2000 w. Elektrotech u Maschinenbau — April 14, 1907. No. 84155 D.

A New Leading-in Conductor for Electric Lamps. C. O. Bastian. Read before the Glasgow Sec. of the Inst. of Elec. Engrs. Describes the Sineplat seal, which consists of enamel glass on copper wire. 1700 w. Elec Engr, Lond—May 17, 1907. No. 84574 A.

Moore Light.

Light from Gaseous Conductors Within Glass Tubes—The Moore Light. D. McFarlan Moore. An illustrated article explaining and describing this system, and reporting comparative tests. 9500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84519 D.

MEASUREMENT.

Candle Power.

The Determination of the Mean Horizontal Candle-Power of Glow Lamps. F. Uppenborn. Abstract trans. from *Elektrotech. Zeitschr.* Describes the four chief methods, investigating the conditions necessary to obtain accurate results. 2500 w. Elect'n, Lond—May 3, 1907. No. 84338 A.

Conductors.

Potential Stresses as Affected by Overhead Grounded Conductors. R. P. Jackson. Introduction to a discussion. A theoretical investigation of the potential gradients and the equipotential surfaces about grounded conductors suspended in the air, and about metallic towers for transmission lines. 1500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84517 D.

Galvanometer.

A New Galvanometer. J. K. A. W. Salomonson. Trans. from *Physikalische Zeitschrift.* A description of the instrument, explaining its uses and stating its advantages. 1600 w. Elect'n, Lond—April 26, 1907. No. 84249 A.

Speed-time Curves.

The Plotting of Speed-time Curves. A. S. Langsdorf. Gives a method, based on rigid laws of the calculus, requiring no approximations, and giving results quickly. 300 w. Elec Wld—May 18, 1907. No. 84417.

Synchroscope.

The Synchroscope. D. H. Cohen. A description of the construction, and more particularly the operation, of this instrument. 800 w. Elec Wld—May 4, 1907. No. 84209.

Thermo-Couple.

Commercial Temperature Measurements with the Thermo-Electric Couple. Anthony Zeleny. Describes apparatus for the accurate measurement of ordinary temperatures by the direct deflections method, considering the problems in connection with the development of pyrometry. Ills. 3500 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84627 N.

Voltage.

Voltmeter Compensator for Direct-Current Circuits. F. E. Haskell. Describes a scheme employed with direct-current equipment which enables the station voltmeter to indicate the e.m.f. at the distribution point. 800 w. Elec Wld—May 25, 1907. No. 84609.

Wheatstone Bridge.

Notes on the Calibration of a Wheatstone Box Bridge. B. E. Smith. Outlines a scheme worked out for the purpose of calibrating a box bridge which was to be used in investigating the electromotive forces developed in thermo-electric couples by small differences of temperature. 1500 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84634 N.

The Wheatstone Bridge. Dana Pierce. Describes the connections and arrangement and use for measuring resistance, explaining the principle it involves. 1600 w. Engr, U S A—May 15, 1907. No. 84409 C.

TRANSMISSION.

High Tension.

Relays for the Control of High-Tension Switchgear. Charles C. Garrard. Discusses points which have proved of importance in experience with the apparatus used in the control of automatic switchgear on high-tension systems. 3500 w. Elec Engr, Lond—April 26, 1907. No. 84245 A.

Lightning.

Lightning Phenomena in Electric Circuits. J. C. Peebles. A discussion of the effects of lightning upon electric conductors, confined mostly to large power transmission lines. 3000 w. Sib Jour of Engng—May, 1907. No. 84558 C.

Line Towers.

Reinforced-Concrete Towers for High-Potential Transmission Line. F. W. Scheidenhelm. Illustrated detailed description of two recently completed reinforced-concrete towers, at Brownsville, Pa., for supporting a line across the Monongahela River. 2800 w. Eng News—May 2, 1907. No. 84041.

Poles.

The Use of Wooden Poles for Overhead Power Transmission. C. Wade. Illustrated report of tests made of A poles and of single poles, with appendix by Prof. Goodman. 6500 w. Inst of Elec Engrs—May 2, 1907. No. 84479 N.

Self Induction.

Oscillations of High Pressure and Frequency in Continuous-Current Circuits (Ueber Schwingungen mit hoher Spannung und Frequenz in Gleichstrom-Netzen). Dr. R. Hiecke. Mathematical discussion of an article with the same title by Herrn Feldmann and Herzog, Sept., 1906. Diagrams. 3300 w. Elektrotech Zeitschr—April 11, 1907. No. 84171 D.

MISCELLANY.

Agriculture.

Electricity in Agriculture (L'Elettricità nell' Agricoltura). Emilio Guarini. Discusses the various ways in which electricity could be used to advantage in agriculture. 3300 w. Serial. 1st part. Elettricità—April 19, 1907. No. 84121 D.

Depreciation.

Depreciation. Robert Hammond. Introduces this question aiming to arouse a discussion and reach a conclusion as to the proper provision which should be made in electrical undertakings. 5000 w. Inst of Elec Engrs—April 25, 1907. No. 84248 N.

Depreciation. Editorial review of recent papers on this subject. Especially the papers of Robert Hammond, P. D. Leake, and Lawrence R. Dicksee. 2800 w. Engng—May 3, 1907. No. 84343 A.

Electrical Engineering.

The Coming of Age of Electrical Engineering. B. A. Behrend. A review of the past development, with some suggestions as to the future outlook. Ills. 2000 w. Cassier's Mag—May, 1907. No. 84051 B.

Granary Equipment.

The Electrical Equipment of a Buenos Ayres Granary. Illustrated description of an electrical installation of somewhat unusual interest. 1000 w. Elec Rev, Lond—April 12, 1907. No. 83871 A.

Print Works.

Electric Motor Driving for Print Works (Der elektrische Antrieb in Zeugdruckereien). Max Arbeiter. Description of results obtained by use of motors in cotton print works. Illus. 2000 w. Elektrotechnische Zeitschrift—March 21, 1907. No. 83649 B.

Radioactivity.

Radioactivity and Atmospheric Electricity. Prof. H. Geitel. Trans. from Umschau. A report of experimental investigations which appear to support the theory that the phenomena of atmospheric electricity can be derived from the observed radioactivity of the soil and ionization of the air. Ills. 2500 w. Sci Am Sup—April 27, 1907. No. 83914.

Rates.

Rates of Charge for Electricity and Their Effect on Cost. J. S. Codman. Read before the Boston and Cornell Branches of the Am. Inst. of Elec. Engrs. Describes the load-factor system and the modifications which represent the best present practice; also methods of determining the customer's maximum demand and consumption. 8500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84508 D.

Selenium.

Use of Selenium in Photometric Measurements (Die Anwendung des Selens zu photometrischen Messungen). Paul von Schrott. Review of what has been accomplished in the study of the properties of selenium. 2000 w. Elektrotechnische Zeischrift—March 28, 1907. No. 83651 B.

Tariffs.

Tariffs from Electric Motive Power. A. C. Hanson. An examination of some of the methods of charging for electrical energy used for motive power purposes. 1800 w. Elec Rev, Lond—April 26, 1907. No. 84247 A.

Modern Methods of Selling Electrical Energy (Tarifications Modernes). Gaston Rosenwald. Discusses the various systems used by Central Stations and describes the leading types of meters employed. Ill. 7500 w. Soc Belge d Elec'ns—April, 1907. No. 84101 F.

Units.

Electric Units (Conferencia sobre Unidades Eléctricas). D. J. M. de Madariaga. Read before the Instituto de Ingenieros Civiles. Mathematical discussion. 1500 w. Serial. 1st part. La Energia Eléctrica—April 10, 1907. No. 84124 E.

INDUSTRIAL ECONOMY

Competition.

"Made in Germany": A Study of Competition. Louis Bell. Discusses the methods of American business as related to foreign competition, stating facts and suggesting remedies. 2500 w. Engineering Magazine—June, 1907. No. 84191 B.

American Competition (La Concurrence Américaine). M. Vialate. The first instalment deals with industrial organization, conditions of labor, industrial legislation, labor unions, etc. Serial. 1st part. 16000 w. Bull Soc d'Encour—March, 1907. No. 84108 G.

Depreciation.

See Electrical Engineering, Miscellany.

Education.

The Education of Mining and Metallurgical Engineers. John Bonsall Porter. Outlines a course of study desirable and gives a report of the work in mining and metallurgy at McGill University. Discussion. Ills. 10000 w. Jour Can Min Inst—1906. No. 83812 N.

The Teaching of Metallurgy in College Laboratories, with a Description of the Metallurgical Laboratories of McGill University. A. Stansfield. A synopsis of the teaching at McGill, with a brief discussion of general principles. Ills. 4200 w. Jour Can Min Inst—1906. No. 83813 N.

Commercial Value of Industrial Schools. Samuel F. Hubbard. Discussion of methods for establishing and managing trade schools that shall be a practical aid in the manufacturing industries. 2500 w. Am Mach—Vol. 30. No. 14. No. 83441.

The Carnegie Technical Schools, Pittsburg, Pa. Day Allen Willey. Information of interest in regard to these schools, with illustrations. 1600 w. Sci Am—April 13, 1907. No. 83578.

Technical Training of Electrical Artisans. C. P. C. Cummins. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Discusses present methods of training and their defects, and outlines a revised system. 6000 w. Elec Engr, Lond—April 19, 1907. No. 83990 A.

A Railroad University. Altoona and Its Methods. Frederic Blount Warren. An illustrated description of the system employed by the Pennsylvania Railroad for the practical training of technical students. 2500 w. Engineering Magazine—May, 1907. No. 83935 B.

The Technical Student and the Engineering Apprenticeship Course. H. Cole Estep. A statement of the present attitude of technical students toward the engineering-apprenticeship courses offered by United States manufacturers. 2000 w. Engineering Magazine—May, 1907. No. 83934 B.

Engineering Business.

Starting an Engineering Business. Sydney F. Walker. An examination of present conditions and the essentials to secure success. 1200 w. Prac Engr—May 17, 1907. Serial. 1st part. No. 84607 A.

Expositions.

The Exposition of the French Physical Society in 1907 (L'Exposition de la Société de Physique en 1907). M. Aliamet. The first instalment deals with the electrical exhibits, accumulators, condensers, lamps, clocks and measuring instruments. Ill. Serial. 1st part. 2500 w. L'Elec'n—April 27, 1907. No. 84107 D.

Types of Machines, Electrical Devices, and Automobiles at the Milan Exposition (Allgemeiner Maschinenbau, Elektrische Einrichtungen und Automobilwesen auf der Ausstellung in Mailand). Herr Pflug. The first instalment describes gas engines, ships coaling devices and the tractor of the Freibahn road train. Ills. 6000 w. Serial. 1st part. Glaser's Annalen—April 15, 1907. No. 84137 D.

Filing System.

Filing System for Technical Information. Oscar E. Perrigo. Illustrated description of a cabinet provided with filing drawers for clippings, storage space for periodicals and a card-index system. 2000 w. Am Mach—Vol. 30, No. 19. No. 84300.

Glasgow.

Industrial Developments in Glasgow.

An account of the extensive industrial migration to the outskirts of the city. Ills. 2200 w. Engng—May 3, 1907. No. 84341 A.

Industrial Betterment.

The Square Deal to the Railroad Employee. H. W. Jacobs. An illustrated account of the extensive work carried out by the A., T., & S. F. Ry. for the benefit of employees. The construction and maintenance of reading rooms, recreation halls, hospitals; improvement of shops and yards; establishing pensions, etc. 2000 w. Engineering Magazine—June, 1907. No. 84192 B.

Inventions.

The Pursuit of Inventing as a Business. George F. Stratton. Gives brief outlines of the methods of work of some successful inventors, and discusses the modern tendency to keep the inventor inventing, and place the exploitation of his inventions in the hands of business managers. 2000 w. Engineering Magazine—June, 1907. No. 84196 B.

The Utility of Inventions. John E. Brady. Explains the meaning of utility as predicated of inventions and why some inventions are not patentable, giving examples of actual cases. 1800 w. Elec Wld—June 1, 1907. No. 84725.

Iron Ore.

The North Swedish Iron-Ore Deposits. Editorial on the recent legislative action by which the Swedish State becomes the proprietor of half the share capital in the company owning the ore deposits which do not already belong to the State. 1700 w. Engng—April 26, 1907. No. 84255 A.

Iron Trade.

Presidential Address. Sir Hugh Bell. A review of the iron trade during the last 100 years. Also an appendix giving a chronological table of some of the more important events connected with iron and steel, during the time covered. 5000 w. Ir & Coal Trds Rev—May 10, 1907. No. 84611 A.

Labor.

A Decision on Rates of Pay for Steam Shovel Men and Engine Runners on the Panama Canal Work. A statement concerning the present rates of pay for the classes of labor named. 1700 w. Eng News—May 9, 1907. No. 84298.

The Labor Problem of the Panama Canal. A. Beeby Thompson. An account of the extensive work accomplished in the solving of the housing, feeding, and health problems, with a discussion of the labor supply. 2800 w. Engng—May 3, 1907. No. 84344 A.

White Labor Situation on the Rand. G. A. Denny. An explanation of present conditions, especially the attitude of the rock-drill miners. 2200 w. Min Jour—May 11, 1907. No. 84440 A.

The Eight-Hour Day in French Government Works. Editorial, outlining the experiments with the eight-hour day made in the French State establishments, which show that reduction in hours of labor cause a reduction in output and a large increase in cost. 2000 w. Engng—May 10, 1907. No. 84636 A.

An Industrial Agreement. Gives the text of the agreement between the Employers' Federation and three unions, which has been provisionally signed by the representatives of both sides, and is awaiting the ratification of the constituents. Also editorial. 2500 w. Engr, Lond—May 3, 1907. No. 84351 A.

Labor Insurance.

Insurance of Labor in Germany. Information in regard to the system, and the laws of Germany which provide against accidents, and for sickness, incapacity and old age; and also the provision made by private companies. 4000 w. Engng—April 19, 1907. No. 84004 A.

Management.

Profit Making in Shop and Factory Management. C. U. Carpenter. This fifth article of a series considers the operation of the machine tools, and conditions necessary for manufacturing at minimum cost. 6000 w. Engineering Magazine—June, 1907. No. 84194 B.

Municipal Ownership.

How Chicago is Solving Municipal Ownership of Transportation Facilities. C. Frederick Collins. Explains the present condition of transportation facilities in Chicago, and the ordinances recently passed which gives the city 55 per cent. of the net profits, and yet leaves the operation of the lines under the management of practical street railway men. 1500 w. Sci Am—May 25, 1907. No. 84544.

Municipal Ownership in England. R. S. Hale. A general discussion of the subject, and of the operation of gas and water works. 4500 w. Cassier's Mag—May, 1907. Serial. 1st part. No. 84047 B.

New South Wales.

The Mineral Industry of New South Wales. F. S. Mance. The output for 1906 shows an increase in value of £1,083,000 as compared with the production of 1905. 2000 w. Eng & Min Jour—May 11, 1907. No. 84315.

Storekeeping.

Storekeeping at the Navy Yards. John A. Mudd. A discussion of the difference between storekeeping under the Naval Supply Fund and that under the Bureau Appropriations, showing the economy and advantages of the former, and related subjects. 18500 w. Pro U S Nav Inst—March, 1907. No. 84023 F.

MARINE AND NAVAL ENGINEERING

Battleships.

The Size of Battleships as a Function of Their Speed. M. J. A. Normand. Trans. from *Bul. de L'Assn. Tech. Maritime.* Aims to give an approximate solution of the problem of determining how the size of fighting ships varies with their speed, when their offensive and defensive powers, as well as their radius of action, remain unchanged. Also comments by D. W. Taylor. 3500 w. Pro U S Nav Inst —March, 1907. No. 84024 F.

Bruges.

The Harbor and Ship Canal of Bruges (Die Häfen und der Seekanal von Brügge). Abstract of a paper by M. L. Coiseau describing the harbor-improvement projects outlined in 1891 and the progress made. Ills. 35000 w. Oest Wochenschr f d Oeff Baudienst—April 6, 1907. No. 84177 D.

Combustion Motors.

Internal-Combustion Engines and Their Application to War Ships (Die Verbrennungskraftmaschine und ihre Verwendung auf Kriegsschiffen). Emil Capitaine. Abstract of a paper in the "Schiffbautechnischen Gesellschaft." Ills. 3000 w. Elektrotech u Polytech Rundschau—April 4, 1907. No. 84168 D.

Crane.

A 150 Ton Hydraulic Crane (Grue Hydraulique de 150 Tonnes). F. Hofer. A description of a large crane recently installed at the Elswick dockyards, Newcastle-on-Tyne, England, illustrated by a detailed plate of the operating mechanism. Ills. 1800 w. Génie Civil—April 13, 1907. No. 84112 D.

Danger Signals.

Kilroy's System of Danger Signals for Warship-Turrets. A means of giving warning to the man in charge of a gun whenever his gun is so trained that by firing it might injure another gun is illustrated and described. It has been adopted by the British navy. 1500 w. Engng—May 10, 1907. No. 84444 A.

Dry-Docks.

Elderslie Graving-Dock. William Park Weir. Cross-sections and description of the construction of this dock on the River Clyde. 1200 w. Inst of Civ Engrs —No. 3639. No. 84464 N.

The Tredegar Dry Dock, Newport, Monmouth. Sigismund Alfred Frech. Illustrated description of the construction, and the methods adopted to overcome the difficulties encountered. 5000 w. Inst of Civ Engrs—No. 3646. No. 84463 N.

Fleet Telephony.

See Electrical Engineering, Communication.

Fog.

The Artificial Dispersion of Fog (De la Dispersion Artificielle du Brouillard). M. Dibos. Discusses the nature and causes of fog and describes the researches of the author on its artificial dispersion, his apparatus, results, etc. Ill. 5000 w. Mem d l Soc d Ing Civ d France—March, 1907. No. 84105 G.

Lighthouse.

Cape Race Lighthouse. Illustrates and describes a new tower of reinforced concrete, cylindrical in form, and higher than the existing structure, about to be erected on the coast of Newfoundland; also the optical apparatus which is of the highest power. 2000 w. Engr, Lond—May 3, 1907. No. 84345 A.

Liner.

The New White Star Liner "Adriatic." Illustrations, with description of this fine vessel, the largest at present afloat. 1200 w. Sci Am—May 25, 1907. No. 84545.

Motor Boats.

The Fourth Annual Motor Boat Exhibition and Races at Monaco. An account of these races with illustrations of some of the fast and novel boats. 2000 w. Sci Am Sup—May 11, 1907. No. 84328.

Motor-Boat Propellers. G. R. McDermott. Presents formulæ for use in the motor-boat field, with explanatory notes. 1800 w. Sib Jour of Engng—May, 1907. No. 84557 C.

Propulsion.

Screw Propellers. T. Sidney Cockrill. Read before the Liverpool Engng. Soc. Considers the general features of screw propulsion and propeller design. 6500 w. Marine Rev—May 2, 1907. No. 84089.

Resistance.

The Resistance of Ships. A. W. Johns. Read before the Inst. of Naval Archts. Considers some of the approximate formulæ for determining the resistance of ships, showing comparisons of the results given by them and those obtained by experiments on models. 3000 w. Engng —April 26, 1907. No. 84257 A.

Shipbuilding.

Newport News Great Shipbuilding Plant. William H. Stone. Information concerning the desirable location and excellent equipment of this plant. Ills. 2000 w. Mfrs' Rec—May 9, 1907. No. 84262.

Shipyards.

Visits to European Navy Yards and Shipyards During the Summer of 1906. Cecil H. Peabody. Describes visits to six navy yards and thirteen private yards, giving plans. 12000 w. Tech Qr—March, 1907. No. 84471 E.

Steamers.

Passenger Steamers for the Cuyaba River, Brazil. Illustrates and describes vessels designed for the exceptionally shallow draught of 18 in. with steam up and bunkers half full. 800 w. Engng—May 10, 1907. No. 84446 A.

Steam Navigation.

Early History of Steam Navigation. An illustrated article reviewing the early history of navigation, especially since the application of steam to the propulsion of vessels. 3500 w. Rudder—May, 1907. Serial. 1st part. No. 84263 C.

Submarines.

The Construction and Handling of Submarines. Walter Bernard. Illustrates and describes the Holland, and the Lake types of submarines under competitive trials at Newport. 1400 w. Sci Am—May 18, 1907. No. 84390.

Tide Signaling.

The Boyd Automatic Tide Signaling Apparatus. Illustrates and describes an apparatus installed at Irvine, Scotland, to inform incoming captains of the state of the tide, as vessels can enter only at high tide. The invention of Martin Boyd. 900 w. Sci Am Sup—May 25, 1907. No. 84549.

Torpedo Boats.

Torpedo Vedette-Boats for the Roumanian Government. Illustrated detailed description of a screw torpedo vedette-boat and its equipment. 1400 w. Engng—April 19, 1907. No. 84003 A.

Vibration.

Vibrations in Recent Steamships (Vibrationserscheinungen neuerer Schnelldampfer). W. Thele. A discussion of vibration diagrams taken by the writer on the "Kaiserin Auguste Victoria," "Amerika," and "Deutschland," the first part of the serial giving a mathematical treatment of the laws of vibration. Ills. 3300 w. Serial. 1st part. Schiffbau—April 24, 1907. No. 84133 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Acetylene.

Dissolved Acetylene. Explains the advantages of this product for use in lighting motor cars, illustrating the mechanical details of the apparatus employed. 2500 w. Auto Jour—April 27, 1907. No. 84239 A.

Air-Cooling.

Air-Cooling of Automobile Engines. John Wilkinson. Explains the science of air-cooling in regard to the internal conditions of the cylinder, and discusses the external conditions. 1800 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84638 F.

Alcohol.

Alcohol as a Fuel for the Automobile Motor. Thomas L. White. Read before the Soc. of Auto. Engrs. Reviews the considerations to be dealt with in using alcohol as a fuel, discussing the carburation problem, and proposing a solution by means of a mixture of acetylene, alcohol vapor and air. 2200 w. Automobile—May 2, 1907. No. 84068.

Brakes.

Brakes and Their Care and Repair. Victor Longheed. Considers the importance of maintaining brakes in proper condition, pointing out the essentials of such maintenance and condition. 2000 w. Automobile—May 2, 1907. No. 84069.

Construction.

Some Features of Automobile Construction. Thomas J. Fay. Read before the Soc. of Auto. Engrs. Discussion of materials and points in construction. 2000 w. Automobile—May 23, 1907. Serial. 1st part. No. 84537.

De la Buire.

The 24 H.P. De la Buire Car. Illustrates and describes features of interest in the design and construction of these French cars. 2000 w. Autocar—May 11, 1907. No. 84435 A.

Electric.

Electrically-Driven Motorcars at the Berlin Automobile Show in 1906 (Elektrisch betriebene Motorwagen auf der Automobilausstellung in Berlin 1906). K. Meyer. Illustrated description of various types. 9000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—April 13, 1907. No. 84143 D.

Enfield.

Some Details of the Enfield Cars. Illustrations and particulars in regard to interesting details of these cars. The engine, steering gears, front axle, and the 25 h.p. change-speed gear. 900 w. Autocar—April 27, 1907. No. 84241 A.

Fire-Engine.

Motor Steam Fire-Engine for Johannesburg. Illustrated description. Liquid fuel is used. 700 w. Engng—April 26, 1907. No. 84254 A.

Gear Box.

Tests of a Speed-Change Gear Box. Richard C. Williams. Describes tests which showed the efficiency of an automobile transmission box to decrease with increase of the speed ratio and to fall off markedly in reverse gear. Ills. 2000 w. Am Mach—Vol. 30, No. 19. No. 84303.

Gears.

Gear Changing. Marcus W. Bourdon. Gives explanations of the various changing movements and suggestions for a noiseless method of changing. 2000 w. Autocar—April 27, 1907. No. 84242 A.

The Fairfax Epicyclic Gear. Explains the epicyclic principle of change-speed gears, and gives an illustrated description of the type. 1500 w. Auto Jour—April 27, 1907. No. 84240 A.

Ignition.

Concerning the Use of the Dry Cell. Arthur P. Jackson. Considers that dry cells, intelligently used, furnish the best ignition. Discusses why they give out quickly and other troubles. 1200 w. Automobile—May 23, 1907. No. 84538.

Motor Omnibuses.

The Management of the Motor Omnibus Company of St. Blaise (Der Betrieb der Motorwagen-Gesellschaft St. Blasen). Herr Pflug. Describes the cars, tariffs and management of a motor omnibus line operating over a difficult line in Switzerland, giving costs. Ills. 2500 w. Zeitschr d Mit Motorwagen Ver—March 31, 1907. No. 84165 D.

Petrol Electric.

The British Thomson-Houston Petrol-Electric System. Illustrates and describes the "simple electric" system adopted by this firm; the present article considers the mechanical features. 1800 w. Auto Jour—May 11, 1907. Serial. 1st part. No. 84434 A.

Petrol Tractors. J. F. Gairns. An illustrated account of the best English practice in the use of gasoline automobile traction. 2500 w. Cassier's Mag—May, 1907. No. 84055 B.

Pilgrim.

The 25-30 H.P. Pilgrim Car. An illustrated description of a British-made car driven by a horizontal engine. 2000 w. Autocar—April 27, 1907. No. 84243 A.

Porthos.

The Porthos Petrol Car. An illustrated description of a car of novel design, having a stationary live-axle enclosed in a rotating tube. 1400 w. Auto Jour—April 27, 1907. Serial. 1st part. No. 84238 A.

Problems.

I. The Automobile. Frederick L. Garlinghouse. II. Automobile Transmission. E. H. Belden. III. Automobile Tires. H. W. Du Puy. Three short papers discussed together. Also short paper on Internal Combustion Engines, by William R. Flint. Ills. 12000 w. Pro Engrs' Soc of W Penn—April, 1907. No. 84026 D.

Road Trains.

The Freibahn Train Automobile (Train Automobile de la Société Freibahn). A. Bidault des Chaumes. Illustrated description of a heavy steam traction engine for hauling heavy loads on highways. 2000 w. Génie Civil—April 27, 1907. No. 84117 D.

Wheels.

Spring Wheels (Federnde Räder). Herr Ruthemeyer - Friedenau. Illustrated detailed description of various types. 2000 w. Zeitschr d Mit Motorwagen Ver—April 15, 1907. No. 84166 D.

COMBUSTION MOTORS.

Alcohol.

The Manufacture, Denaturing, and the Technical and Chemical Utilization of Alcohol. M. Klar. The present number considers the distillation of alcohol, its production from starch, yield of wash and of volatile by-products. 2000 w. Sci Am Sup—May 11, 1907. Serial. 1st part. No. 84332.

Alcohol Engines to Replace Gasoline Engines. John Preston. Remarks on some of the advantages of denatured alcohol and some of the differences between the behavior of an engine when running on gasoline and its action with alcohol. 1000 w. Sci Am—May 11, 1907. No. 84327.

Design.

The Design of Modern Producers and Gas Engines. R. E. Mathot. Presents in the present article the general principles of construction considered as the best practice. 3000 w. Engineering Magazine —June, 1907. No. 84198 B.

Efficiency.

Effect of Size on the Thermal Efficiency of Explosion Motors. H. L. Callendar. Discusses losses of heat to the cooler walls of the cylinder during ignition and expansion. 3500 w. Mech Engr—May 18, 1907. Serial. 1st part. No. 84623 A.

Fuels.

Liquid Fuels and Their Utilization in Combustion Engines, with Special Reference to the Diesel Motor (Die flüssigen Brennstoffe und ihre Ausnutzung in der Verbrennungskraftmaschine, mit besonderer Berücksichtigung des Dieselmotors). Karl Kutzbach. Comparison of the relative values of various fuels. Ills. 7800 w. Serial. 2 parts. Zeitschr d Ver Deutscher Ing—April 6 and 13, 1907. No. 84140 D

Investigations on the Application of Tar Oils in the Operation of Diesel Motors (Versuche über die Verwendung von Teerölen zum Betrieb des Dieselmotors).

Paul Rieppel. Investigations on the values of various oils as fuels for internal-combustion motors, with special reference to tar oils. Curves and Diagrams. 5500 w. Zeitschr d Ver Deutscher Ing—April 20, 1907. No. 84145 D.

Gas Engines.

Producer Gas Engines. G. W. Bissell. Abstract of a paper read before the Iowa Elec. Assn. A report and comparison of tests made. 800 w. Elec Ry Rev—May 11, 1907. No. 84280.

The Two vs. the Four-Stroke Cycle Gas Engine. Louis Illmer, Jr. A discussion favoring the two-stroke cycle engine and recommending independent air and gas pumps. 3500 w. Engr, U S A—May 15, 1907. No. 84408 C.

Gasolene Engines.

Offset Cylinders in Gasoline Engines. E. J. Bartlett. A technical discussion of the conditions and the method of evening the pressure by offsetting the center of the cylinder from that of the crank-shaft so that the angle of the connecting-rod is unequal during the two strokes. 1500 w. Am Mach—Vol. 30, No. 20. No. 84376.

Gas Producers.

Steam in Gas Producer Practice. William Arthur Bone. Read before the Ir. & St. Inst. A record of experiments made to determine the influence of variation in the proportions of air and steam in the blast upon the composition of the blast, its suitability for furnace operations, and upon the thermal efficiencies of the producers. 7500 w. Engng—May 17, 1907. No. 84581 A.

Equations and Diagrams of the Operations in the Gas Producer (Gleichungen und Diagramme zu den Vorgängen im Gasgenerator). R. Mollier. Mathematical and graphical representations of the operation and products of a gas producer under various working conditions of air and water supply. Diagrams. 3600 w. Zeitschr d Ver Deutscher Ing—April 6, 1907. No. 84141 D.

Gas Turbines.

The Gas Turbine (Le Turbine a Gas). Giuseppe Belluzzo. A general review of theory and practice. Ills. 1500 w. Serial. 1st part. L'Industria—April 28, 1907. No. 84122 D.

On the Problems of the Gas Turbine (Zur Frage der Gasturbine). Felix Langen. A practical discussion of various points in gas turbine operation. 1600 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 10, 1907. No. 84158 D.

Water Gas.

Water Gas (Das Wassergas). Herr Kayser. Discusses the use of water gas for lighting, heating and power purposes, describes its generation and gives tables of costs of actual plants, notably the municipal plant at Berlin. Ills. 6000 w. Gesundheits Ing—April 6, 1907. No. 84182 D.

HEATING AND COOLING.

Car Sheds.

Heating Large Car Inspection Sheds. The heating of the sheds of the Brooklyn Rapid Transit Co. is described, also the down-draft forge installation. 2200 w. Eng Rec—May 18, 1907. No. 84429.

Fans.

Centrifugal Electric Driven Fans. John Howatt. Considers fans for producing artificial ventilation. 2300 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84631 N.

Furnaces.

Megass Furnaces. Richard Lloyd. Describes some trials of ordinary megass furnaces, as used in British Guiana, with special reference to the quantity of air admitted for combustion. Ills. 2200 w. Inst of Civ Engrs, No. 3643—No. 84462 N.

Heat Absorption.

Heat Absorption Through Tubes. William R. Billings. Considers the effect of using water in small streams at high velocity. Ills. 2000 w. Engr, U S A—May 15, 1907. No. 84407 C.

Hot Water.

Preliminary Report of the Committee to Secure Data on Hot Water Heating. Gives Data covering present practice in various parts of the country. The subject is considered under the heads of boilers, radiation, and piping. 3000 w. Heat & Vent Mag—May, 1907. No. 84456.

Reasonable Hot-Water Heating Plants (Billige Warmwasserheizanlagen). E. Stadelmann. A short article on this subject with a prolonged discussion between the author and Fritz Gerlach. Diagram. 4500 w. Gesundheits Ing—April 13, 1907. No. 84183 D.

Mechanical Plant.

Heating and Ventilating the People's Palace, Boston. Detailed description of the mechanical plant for a five-story building for the Salvation Army. Heating is by direct radiation on the two-pipe system. Ventilation supplies a filtered air supply and exhausts foul air. Ills. 3500 w. Eng Rec—May 4, 1907. No. 84223.

Norway.

An Example of Heating Practice in Norway. Alf. Tjersland. Illustrated description of the usual type of heating system used, and an explanation of the method followed for determining the loss of heat from buildings and the amount of radiation needed. 1500 w. Met Work—May 18, 1907. No. 84357.

Refrigeration.

Mechanical Refrigeration. Alex. M. Blumenthal. An explanation of systems of refrigeration, the processes and apparatus used. 3500 w. Engr, U S A—May 15, 1907. No. 84406 C.

Store-House Heating.

Cost of Heating Store Houses. H. O. Lacount. Investigates the cost of heating store-houses equipped with automatic sprinklers to prevent the freezing of the pipes. Compares with cost of dry-pipe, and calcium chlorid sprinkler equipments. 7000 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84646 F.

Tunnels.

Ventilating a German Tunnel. Illustrated description of the ventilating plant for the Kaiser Wilhelm tunnel at Cochem. 1000 w. Engr, Lond—May 10, 1907. No. 84451 A.

HYDRAULICS.

Centrifugal Pumps.

The Roturbo Centrifugal Pump. Illustrates and describes a new type of centrifugal pump invented by E. S. G. Rees. 1600 w. Engr, Lond—May 17, 1907. No. 84586 A.

The Operation of Governing Mechanisms on Centrifugal Pumps and Blowers (Die Wirkung von Leitvorrichtungen bei Zentrifugalpumpen und Gebläsen). W. Grun. Mathematical discussion of various types. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—April 6, 1907. No. 84142 D.

The Spiral Shell of Turbines, Centrifugal Pumps, etc. (Die Spiralgehäuse von Turbinen, Kreiselpumpen, usw.). Rudolf Lorenz. Mathematical discussion of its design. Ills. 2400 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 30, 1907. No. 84161 D.

Gates.

Water Power Plants with Waste Sluices for the Utilization of High Water (Wasserkraftanlagen mit Ejektorenschützen zur Ausnutzung von Hochwasser). Illustrated description of installations to prevent the drowning of the turbines during periods of high water, the first installment dealing with the plant at Chèvres. 1600 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 30, 1907. No. 84164 D.

Floating Gates in the Operation of Turbine Plants (Schwimmender Schützen zur Instandhaltung von Turbinenanlagen). A. Stoll. Illustrated description of an installation at Chèvres on the Rhone. 2000 w. Zeitschr f d Gesamte Turbinenwesen—April 20, 1907. No. 84160 D.

Pumping Machinery.

Pumping Machinery for the New Graving Dock, Colombo, Ceylon. Illustrations showing the machinery and general arrangement of the plant, with descriptive notes. 1000 w. Engng—May 17, 1907. No. 84577 A.

Rams.

Contribution to the Study of the Theory of the Hydraulic Ram (Contribución al Estudio de la Teoría de los Arietes Hidráulicos). Francisco Mirapeix. Mathematical paper. Ills. 6000 w. Serial. 1st part. Revista Tecno-Ind—March, 1907. No. 84125 D.

Stream-Flow Measurement.

See Mechanical Engineering, Measurement.

Theory.

Some Problems Connected with the Flow from Vessels (Alcuni Problemi sull' Efflusso dai Vasi). Pietro Alibrandi. A mathematical discussion of the whole subject of the flow of water through orifices. Ills. 80000 w. Ann della Soc Ing e d Arch Ital—Vol. XXI, No. 3. No. 84126 F.

Turbines.

Contribution to the Discussion of Water Flow in Turbines (Zur Diskussion der Wasserbewegung in Kreiselrädern). Herr Riebensahm. Discussion of Viktor Kaplan's article in this paper of Feb. 20. 1700 w. Zeitschr f d Gesamte Turbinenwesen—April 10, 1907. No. 84159 D.

Demonstration of the Correctness of the Present Common Turbine Theory on the Basis of Brake Tests on Turbine Plants in Actual Operation (Nachweis der Richtigkeit der derzeit gebräuchlichen Turbinentheorie auf Grund von Bremsproben an ausgeführten Turbinenanlagen). Viktor Kaplan. Answer to Dr. Lorenz's article of Feb. 28. 2000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 30, 1907. No. 84163 D.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball Bearings. Henry Hess. A discussion of their use in general and on automobiles in particular. Also Prof. Stribeck's reports on ball bearings for various loads. Ills. 18500 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84649 F.

The Care and Repair of Bearings. Herbert L. Towle. Considers bearing materials, bearing fit, wear, repair, lubrication, etc. Ills. 3500 w. Rudder—May, 1907. No. 84264 C.

Boiler Making.

A Layout for a Boiler Maker. A. N. Lucas. Discusses flue work, patching, plugging cracks, stay-bolt work, renewing sheets in fire-boxes, building new boilers, etc. Diagrams. 2500 w. Boiler Maker—May, 1907. No. 84018.

Boring.

A Boring and Turning Mill. Illustrates and describes a mill of exceptionally strong design, adapted for work up to 100 in. in diameter and 4 ft. long. 800 w. Engr, Lond—May 3, 1907. No. 84347 A.

Brass Works.

The Langsenkamp - Wheeler Brass Works. Illustrated description of this Indianapolis plant. 1700 w. Foundry—June, 1907. No. 84597.

Brazing.

Brazing of Iron Surfaces. John L. Bacon. Materials and methods for joining cast and wrought iron are illustrated and described. 1500 w. Engr, U S A—May 1, 1907. No. 84036 C.

Car Wheels.

Modern Manufacture of Car Wheels (Die Moderne Fabrikation der Eisenbahnradsätze). Arthur Boeddecker. Illustrates and describes, in the first instalment, various machines for shaping spokes. 800 w. Serial. 1st part. Eisenbahntech Zeitschr —April 10, 1907. No. 84167 D.

Castings.

Aluminum Castings. E. F. Lake. Reviews the history of the discovery and development of tne use of the metal aluminum, discussing the physical properties, and the making of aluminum castings. Ills. 2500 w. Foundry—May, 1907. No. 84058.

Bronze Castings for Automobiles. E. F. Lake. Considers the various combinations of alloys used to produce the different grades. 3000 w. Foundry—June, 1907. No. 84596.

Casting Copper. C. Vickers. Suggestions and discussion of the influence of various alloys. 1200 w. Foundry—June, 1907. No. 84598.

Casting Rolls for Bending Boiler Plate. R. H. Palmer. Illustrates and describes the method used. 1800 w. Foundry—June, 1907. No. 84591.

Defects in Foundry Practice with Especial Reference to Armature Casting (Fehler in der Giessereipraxis unter besonderer Berücksichtigung des Armaturengusses). H. Kloss. The first instalment of the serial discusses faults in construction, design, moulds and casting, and mixtures. 2300 w. Serial. 1st part. Stahl u Eisen—April 3, 1907. No. 84129 D.

False Back Repetition Casting. Walter J. May. Suggestions for making false backs or capes in plaster when economy is necessary. 1500 w. Prac Engr—May 3, 1907. No. 84335 A.

The Cores Used for the Large Dredge Cutter. John Gregson, Jr. Explains details of molding of a large cutter head for a suction dredge. 700 w. Am Mach—Vol. 30, No. 19. No. 84302.

The Skim-Gate and Its Value in Making Sand Castings. Illustrates and describes the "Renshaw skim-gate," explaining its value in making clean castings. 1700 w. Brass Wld—May, 1907. No. 84454.

Chains.

Weldless Chain Manufacture. Illustrates and describes the process employed by the Handelsgessellschaft Kleinberg & Co., Vienna, Austria. 1800 w. Ir Age—May 9, 1907. No. 84277.

Cleaning.

The Chemical Cleaning of Iron and Steel (Le Décapage Chimique du Fer et de l'Acier). E. Lemaire. A review of the methods used for cleaning iron and steel by means of acid baths in preparation for a protective covering, giving data as to loss of weight in baths of various acids. Ills. 4700 w. Génie Civil—April 27, 1907. No. 84119 D.

Cranes.

The Pawling & Harnischfeger Renewal Bulletins. An illustrated article explaining a system for facilitating the ordering of repairs or renewals for broken-down cranes. 1100 w. Ir Age—May 16, 1907. No. 84366.

Dies.

A Set of Shell-Drawing Dies for a Single-Acting Press. Julius F. A. Vogt. Illustrated description calling attention to new features. 1300 w. Am Mach—Vol. 30, No. 20. No. 84379.

Forging Press Dies for Making Hammers. Illustrates and describes their proper construction. 1500 w. Am Mach—Vol. 30, No. 18. No. 84038.

Drawing Presses.

The Calibration of Drawing-Press Tools (Die Kalibrierung der Ziehpresswerkzeuge). Karl Musiol-Warschau. Illustrated mathematical discussion of the proportioning of dies in drawing-press work. Tables. 2500 w. Serial. 1st part. Stahl u Eisen—April 3, 1907. No. 84128 D.

Epicyclic Trains.

Calculations Respecting Epicyclic Wheel Trains. Francis J. Bostock. Gives derivation of formulae for several usual types, and extension of the method of analysis to a somewhat complex epicyclic train. 1800 w. Diagrams. Am Mach—Vol. 30, No. 20. No. 84375.

Exposition.

Machine Tools at the International Automobile Exposition in Berlin, 1906 (Die Werzeugmaschinen auf der Internationalen Automobil-Ausstellung, 1906, in Berlin). The first instalment illustrates and describes various types of lathes and other machines exhibited. 1200 w. Serial. 1st part. Zeitschr f Werkzeugmasch—April 5, 1907. No. 84175 D.

Foundries.

A Modern Gray Iron Foundry. Illustrated description of the new plant of the Babcock & Wilcox Co., at Barberton, O., and of some of the molding methods. 2500 w. Ir Trd Rev—May 16, 1907. No. 84363.

Plant of the Scullin-Gallagher Iron & Steel Co. Illustrated description of a large steel foundry in St. Louis. 2500 w. Foundry—June, 1907. No. 84594.

Galvanizing.

The Art of Galvanizing. Alfred Sang. Read before the Am. Found. Assn. Remarks on corrosion and methods of protecting iron and steel, metallic coatings and their behavior, action of metals in contact, specifications for an ideal coating, cold, hot and dry galvanizing, etc. 5000 w. Ir Age—May 23, 1907. Serial. 1st part. No. 84486.

Gear-Cutting.

Two German Bevel Gear Shaping Attachments. Illustrates and describes two devices designed for planing bevel gears, using templets or cams in giving the proper shape to the tooth. 1500 w. Mach N Y—May, 1907. No. 84021 C.

Gears.

Spiral Gearing by the Hindley Process. Illustrates and describes an extension of the Hindley principle to cover gears of low speed ratio with large increase in area of contact. 1000 w. Am Mach—Vol. 30, No. 20. No. 84374.

Guns.

Birmingham Small Arms. Illustrated description of this English plant for the production of these weapons, and some of the machines used. 5000 w. Engr, Lond —May 10, 1907. No. 84449 A.

Industrial Locomotives.

Industrial Locomotives (Die Baulokomotiven). A. Doeppner. Gives details of industrial locomotives of various powers and compares them with horses as regards cost of haulage. Ills. 2000 w. Zeitschr Ver Deutscher Ing—April 27, 1907. No. 84149 D.

Ingot Molds.

Note on the Distribution of Sulphur in Metal Ingot Molds. J. Henderson. Calls attention to the fact that much more sulphur is found in the tops of ingot molds, giving results of sampling from the top and bottom, and other matters of interest. 600 w. Ir & Coal Trds Rev—May 10, 1907. No. 84617 A.

Jig.

Improving a Milling Jig. George G. Little. Sketches and notes showing how a defective jig was made to give less trouble. 1000 w. Am Mach—Vol. 30, No. 21. No. 84491.

Lathes.

Motor Drive for Lathes. Illustrates and describes several interesting applications. 1200 w. Ir Age—May 9, 1907. No. 84276.

The Development of the Lathe (Die Entwicklung der Schnelldrehbänke). A historical sketch of the evolution of the lathe and lathe practice. Tables. 2000 w. Zeitschr f Werkzeugmasch—April 25, 1907. No. 84176 D.

Locomotive Works.

Baldwin Locomotive Works. John V. Martenis. A brief sketch reviewing the development of these works. Ills. 1600 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84626 N.

Machine Details.

A Factor in the Design of Machine Details. T. E. Stanton. Presents experimental evidence giving definite numerical results as to the loss of strength to be anticipated from such changes of section as are common in machine design when using the ordinary materials of construction. Ills. 1200 w. Engng—April 19, 1907. No. 84000 A.

Milling Cutters.

Tooth Relief for Milling Cutters—A Criticism. John Edgar. Discussing opinions of H. T. Millar, as expressed in an earlier article. Ills. 1600 w. Am Mach —Vol. 30, No. 21. No. 84489.

Mixers.

The Use of a Heated Foundry Mixer, J. B. Nau. Presents the advantages of the heated mixer, describing a design by the writer. 700 w. Ir Age—May 23, 1907. E + F.

Molding.

A Dry-Sand Mold with a Very Thin Core. Illustrates and describes an interesting way of making a mold in dry sand, with its very thin core, the method of supporting it and the pouring of the casting. 1000 w. Am Mach—Vol. 30, No. 19. No. 84299.

Molding Part of a Type-Casting Machine. R. H. Palmer. Describes methods of molding in dry sand and in green sand, and of treatment after pouring, in order to insure a satisfactory casting. Ills. 1500 w. Am Mach—Vol. 30, No. 20. No. 84380.

Ordnance.

The Ordnance Department as an Engineering Organization. William Crozier. An address delivered at the dedication of the Engineering Societies' building in New York, April 18, 1907. Ills. 8000 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84644 F.

105-Millimetre and 120-Millimetre Quick-Firing Field Howitzers. Illustrated description of howitzers embodying the Ternstrom device for controlling automatically the length of recoil. 3000 w. Engng—May 10, 1907. No. 84443 A.

Patterns.

A Double Chute Hopper Pattern. H. J. McCaslin. Describes the construction of the core boxes and methods of molding. Ills. 1600 w. Foundry—May, 1907. No. 84060.

Pattern for a Heavy Ajax Forging Machine Frame Casting. Jabez Nall. Illustrates and describes the method of molding. 4000 w. Foundry—June, 1907. No. 84592.

Pig Iron.

Foundry Pig Iron Specifications. Herbert Pilkington. Read before the British Found. Assn. Discusses conditions in connection with the production of pig iron, grading, silicon variation, sulphur, remelting, etc. 3000 w. Foundry—June, 1907. No. 84595.

Sand Blasts.

Sand Blasting Appliances. J. M. Betton. On the proper arrangement of cleaning rooms with suggestions for their equipment. 1400 w. Foundry—June, 1907. No. 84593.

Shop.

A Shop with a History. H. P. Fairfield. Illustrated review of the history of the Putnam shop in Fitchburg, Mass. 1500 w. Mach, N Y—May, 1907. No. 84019 C.

Structural Steel.

An Electrically Operated Structural Plant. Illustrated description of a plant for manufacturing ornamental and structural steel work for buildings and bridges. 1600 w. Eng Rec—May 4, 1907. No. 84224.

Taps.

Cutting Taper Threaded Taps with Chasers. Erik Oberg. Considers the conditions of cutting a taper thread with a chaser, particularly the case of a pipe tap with a total taper of ¾ in. per foot, cut with a chaser supposed to be held in a threading tool-holder. Diagrams. 900 w. Mach, N Y—May, 1907. No. 84022 C.

Tempering.

Furnaces for Tempering High-Speed Steel. C. U. Scott. Suggestions for the fitting up of a hardening room, and the treatment of the tools. 1500 w. Am Mach—Vol. 30, No. 19. No. 84301.

The Exposition of Tempering Processes (Exposition des Procédés de Trempe). M. Ch. Rosambert. Descriptions of the furnaces, pyrometers and processes shown at this exposition at Vienna, May-July, 1906, with brief reviews of the technical papers read at the conferences of metallurgists held in connection. Ill. 12500 w. Rev d Metal—April, 1907. No. 84100 E + F.

Thread Tools.

Thread Tools for Threads with Rounded Top and Bottom. E. A. Johnson. Describes the tools and methods used in making the Whitworth thread tools. Diagrams. 1200 w. Mach, N Y—May, 1907. No. 84020 C.

Tools.

High-Speed Steel Tools. E. R. Norris. Discusses the making, life, and shape of the tool, its applications, etc., referring to other papers on this subject. 4500 w. Elec Jour—May, 1907. No. 84475.

Westinghouse.

A brief History of the Westinghouse Machine Company. Edward H. Sniffin. Review of the period covering the manufacture of steam engines, gas engines, steam turbines, and stokers. 4500 w. Elec Jour—May, 1907. No. 84476.

Wire.

The Telephone Wire Plant. Sergius P. Grace. Explains some of the factors in the design of the wire plant, and discusses some of the problems. Ills. 4000 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84518 D.

MATERIALS OF CONSTRUCTION.

Automobiles.

Material for Automobiles. Elwood Haynes. An examination of the various metals used, and the parts for which certain materials are adapted. 3500 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84639 F.

Special Auto Steel. Thomas J. Fay. Gives 4 tables of data of the various grades of steel, stating the results of reliable tests. and giving a detailed discussion of the relative value of the several products. Ills. 7000 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84647 F.

Cast Iron.

Chemical Properties of Malleable Cast-Iron. G. A. Akerland. Compares malleable and gray iron, showing annealing changes, and giving tests and experiments. 1200 w. Foundry—June, 1907. No. 84590.

Manganese Steel.

Manganese Steel and Some of Its Uses. E. F. Lake. Calls attention to some of the peculiarities of this material, and its advantages over carbon steel for rails subject to severe wear, for burglar-proof vaults, etc. 2000 w. Am Mach—Vol. 30, No. 20. No. 84378.

Screws.

Standard Proportions for Machine Screws. Revised report of the committee on standard proportions for machine screws. 2500 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84500.

Steel.

Carbon Tungsten Steels. Thomas Swinden. An investigation of varying percentages of carbon in the presence of a constant percentage of tungsten. 5500 w. Ir & Coal Trds Rev—May 10, 1907. No. 84619 A.

The Ageing of Mild Steel. C. E. Stromeyer. A report of the writer's investigations, describing tests made. 1100 w. Ir & Coal Trds Rev—May 10, 1907. No. 84620 A.

Steel Sheets.

I. History of the Development of the Manufacture of Iron and Steel Sheets. W.

C. Cronemeyer. II. Sheet Metal Manipulation. Frank I. Ellis. Two papers discussed together. Ills. 11000 w. Pro Engrs' Soc of W Penn—May, 1907. No. 84624 D.

Steel Tubes.

Pressures on Lap-Welded Steel Tubes. Prof. Reid T. Stewart. Supplement to an earlier paper on the effects of the distortion due to successive re-tests on the collapsing pressures of 10-inch lap-welded steel tubes. 1500 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84501.

Tool-Steel.

An Analysis of the Evolution of Modern Tool-Steel. Prof. H. C. H. Carpenter. A paper inspired by the presidential address of F. W. Taylor, aiming to trace the evolution of tool steel in the light of recent knowledge. The present number considers current theories of hardening, and the wear of tools in cutting metals. 4800 w. Engng—May 3, 1907. Serial. 1st part. No. 84340 A.

Vanadium Steel.

Some Properties of Vanadium Steel. E. F. Lake. How small quantities of vanadium affect iron and steel and where it is most useful. 2500 w. Am Mach—Vol. 30, No. 18. No. 84039.

Wire Rope.

The Strength of Wire Rope (Die Beanspruchung von Drahtseilen). J. Isaachsen. Mathematical discussion of the stresses set up in wire rope under tension and flexure. Diagrams. 5000 w. Zeitschr d Ver Deutscher Ing—April 27, 1907. No. 84148 D.

MEASUREMENT.

Cooling Curves.

Methods in Obtaining Cooling Curves. C. L. A. Schmidt. Brief explanation of methods, with illustrations of apparatus used. 1600 w. Cal Jour of Tech—May, 1907. No. 84650.

Hardness.

Testing Hardness of Metals and Materials. W. J. Ballentine. Describes a process making use of a new form of impact-testing instrument which is simple in construction. 1700 w. Am Mach—Vol. 30, No. 20. No. 84377.

Polygons.

Computation Table for Regular Polygons. W. L. Benitz. Gives two tables aiming to simplify the calculations for any required dimensions of regular polygons. 800 w. Am Mach—Vol. 30, No. 21. No. 84490.

Stream Flow.

Methods Employed by the U. S. Geological Survey for Obtaining Winter Records of Stream Flow by Means of Current Meter Stations. Information from a paper by H. K. Barrows and Robert E. Horton. 1500 w. Engng-Con—May 15, 1907. No. 84365.

Lea's Patent Water Recorder. Illustrates and describes an instrument for measuring and recording graphically the rates of flow of water or other liquid when passing freely over weirs or through orifices. 1800 w. Mech Engr—April 27, 1907. No. 84244 A.

Temperature.

Practical Pyrometry. Robert S. Whipple. Illustrates and describes many types of thermometers and some of the applications. Discussion. 6500 w. Jour W Soc of Engrs—April, 1907. No. 84529 D.

Sentinel Pyrometers and Their Application to the Annealing, Hardening, and General Heat Treatment of Tool Steel. Harry Bearley and F. Colin Moorwood. An account of the use of sentinel pyrometers showing their practical utility. 3000 w. Ir & Coal Trds Rev—May 10, 1907. No. 84618 A.

Wind Gage.

A New Direct-Reading Wind Gage. Dr. Alfred Gradenwitz. Illustrates and describes a novel wind gage constructed by Max Kohl, and also a wind gage constructed on plans by E. Geyer which renders it possible to read the direction of the wind both by day and night at any distance. 1200 w. Sci Am Sup—May 18, 1907. No. 84394.

POWER AND TRANSMISSION.

Air Compressors.

The New Franklin Air Compressors. Illustrated description of compressors made in Chicago. 1600 w. Ir Age—May 9, 1907. No. 84278.

Crane-Hooks.

An Experimental Investigation of the Maximum Stresses in Loaded Crane-Hooks. John Goodman. A comparison of old and new theories, giving data obtained by experiment upon wrought-iron crane-hooks. 3300 w. Inst of Civ Engrs—No. 3655. No. 84461 N.

Economics.

Economy in Power. A. Stucki. Discusses the question of relative economy in fuel and briefly considers the cost and maintenance of the installation, reliability, safety, attendance, and adaptability. 2500 w. R R Gaz—May 10, 1907. No. 84288.

Power Costs. Charles E. Lucke. Read before the Am. Elec. Chem. Soc. A comparison of costs of water, steam, oil, and gas power, with discussion. 4800 w. Elec Rev, N Y—May 18, 1907. No. 84415.

Electric Power.

Electrically Operated Equatorial Mountings for Telescopes. Illustrates and describes the construction recently invented by Herr F. Meyer, in which electricity is the motive power used. 1200 w. Sci Am Sup—May 18, 1907. No. 84393.

Breaking the Record in Newspaper Making. Day Allen Willey. Illustrated description of the new plant of the Baltimore *Sun*, which is electrically driven. 2000 w. Elec Rev, N Y—May 18, 1907. No. 84414.

The Electric Plant at the Burbacher Hutte. Illustrated description of the electrical equipment of these German steel works. 1200 w. Engr, Lond—May 17, 1907. No. 84587 A.

An Electrically Driven Cement Works. Illustrated description of works at West Hartlepool recently changed from oil-engines to three-phase induction motors. 2500 w. Elec Engr, Lond—May 17, 1907. No. 84573 A.

Elevator Capacity.

The Comparative Capacity of Elevators and Escalators for Handling Crowds. Charles D. Seeberger. Concludes that the platform area per unit of time affords a perfect standard for comparison. 900 w. Eng News—May 2, 1907. No. 84043.

Elevators.

Boddam's Hydro-Electric Lift. Illustrates and describes an arrangement having the advantages of the hydraulic lift and the electrically driven lift combined. 1000 w. Engng—May 17, 1907. No. 84580 A.

Gas Plant.

A New Producer Gas Plant. Illustrated description of a plant installed in a Chicago factory. 1500 w. Engr, U S A—May 1, 1907. No. 84037 C.

Pneumatic Tools.

Some Late Improvements on Compressive Riveters and Other Tools. Chester B. Albree. An illustrated talk on new features recently introduced. Discussion. 4500 w. Pro Engrs' Soc of W Penn—May, 1907. No. 84625 D.

Power Plants.

Hydro-Electric Power versus Steam for Industrial Plants. H. von Schon. This third article of a series describes some typical modern stations, and calls attention to undeveloped powers in various parts of the United States. Ills. 7000 w. Engineering Magazine—June, 1907. No. 84193 B.

A Model Plant in a Fine Office Building. Illustrated description of the plant for heating and electric light, motors being supplied for driving elevator pumps, printing presses, and ventilation fans, for the building of the Security Mutual Life Insurance Co., at Binghamton, N. Y. 3000 w. Engr, U S A—May 1, 1907. No. 84035 C.

STEAM ENGINEERING.

Boilers.

Efficiency in Steam-Boiler Practice. Percival Cooke. Treats of the efficient performance of steam boilers from the position of the manufacturer. Ills. 4500 w. Cassier's Mag—May, 1907. Serial. 1st part. No. 84052 B.

Automatic Counter-Current and Water-Circulating Device for Fire and Water-Tube Boilers (Selbsttätiger Gegenstrom- und Wasserumlauf-Erzeuger von Kunert für Flamm- und Heizrohrkessel). Herr Förster. Illustrated detailed description of the device and results of elaborate tests of its efficiency. 4500 w. Zeitschr d Ver Deutscher Ing—April 27, 1907. No. 84146 D.

Combustion.

Efficiency in the Burning of Fuel Under the Steam Boiler. William D. Ennis. This first article of a series deals with the influence of air supply upon economy of combustion, the means of discovering whether the conditions are right in any given plant, and the remedies needed. 5500 w. Engineering Magazine—June, 1907. No. 84179 B.

Engine Wreck.

An Unusual Engine Wreck. Milton W. Arrowood. Describes an accident to an engine used to furnish power for a large grain elevator, and the method of repair. Ills. 1000 w. Am Mach—Vol. 30, No. 20. No. 84381.

Fuel.

Burning Fine Anthracite Coal. R. T. Strohm. Discusses points in connection with the successful burning of low-grade fuel, types of furnace, firing, etc. Ills. 2500 w. Elec Wld—May 4, 1907. No. 84212.

Lubricants.

Deflocculated Graphite and the "Acheson Effect." Orrin E. Dunlap. Describes a recent invention of E. G. Acheson which reduces graphite practically to the molecular state, stating some of its possibilities as a lubricant. 2000 w. Sci Am—May 11, 1907. No. 84326.

The Properties and Use of Mineral Lubricating Oils. P. F. Walker. Considers methods of testing oils for their friction-reducing values, showing the need of investigating all phases of the oil question, especially the film-forming properties. 4000 w. Engineering Magazine—June, 1907. No. 84635 B.

Oil Burners.

The Application of Oil Burners to Steam Boilers. William Kavanagh. Gives some facts pertaining to oil burners, their structure and application to steam boilers. Ills. 1500 w. Elec Wld—May 4, 1907. No. 84211.

Pumping Engines.

Balancing of Pumping Engines. A. F. Nagle. An investigation as to the proper weight of the plungers of a vertical, triple-expansion, crank and flywheel pumping engine. 1600 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84502 F.

Smokestacks.

The Calculation of Smokestacks for Manufactories (Die Berechnung von Fabrikschornsteinen). C. Gaab. Discusses the findings of a commission appointed by the Prussian Minister of Public Works to investigate conditions of safe construction of smokestacks. 6200 w. Zeitschr d Ver Deutscher Ing—April 27, 1907. No. 84147 D.

Superheating.

Entropy Lines of Superheated Steam. Arthur M. Greene, Jr. Gives results of experiments of Knoblauch and Jakob. Curves and diagrams. 1500 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84645 F.

Experiences with Superheated Steam. George H. Barrus. Notes dating back to 1874 on the writer's experiences with superheated steam. 2500 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84504 F.

Flow of Superheated Steam in Pipes. E. H. Foster. Gives conclusions reached from data collected, showing that the laws governing the flow of superheated steam differ from those governing saturated steam. 700 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84505 F.

Specific Heat of Superheated Steam. Discussion by R. W. Stovel of the paper by A. R. Dodge on this subject. 1400 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84507 F.

Materials for the Control of Superheated Steam. M. W. Kellogg. Deals particularly with pipe, fittings, valves, and the details connected therewith, such as joints, gaskets, etc. 2300 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84648 F.

Superheat and Furnace Relations. Reginald Pelham Bolton. Considers methods of generating superheated steam, and their improvement. 1400 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84637 F.

Superheated Steam on Locomotives. H. H. Vaughan. On the use of superheated steam on locomotives in the United States and Canada, illustrating and describing types of superheaters applied, giving economical results, and maintenance results, and conclusions. 3500 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84640 F.

The Cole Locomotive Superheater. W. F. M. Goss. Notes concerning the performance of the Cole superheater as applied to the Purdue University locomotive "Schenectady No. 3." 1000 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84506 F.

Use of Superheated Steam in an Injector. Strickland L. Kneass. Note on the essentials to obtain good results from an injector with superheated steam. 500 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84503 F.

Turbines.

The Steam Turbine (Die Dampfturbine). Herr Hofweber. General review of the principles of the various types of steam turbine describing their construction, with special reference to the Zoelly turbine. Ills. 5000 w. Two parts. Zeitschr d Oest Ing u Arch Ver—April 12 and 19, 1907. No. 84179 each D.

The Ideal Condensation for Steam Turbines for Land and Marine Service (Die ideale Kondensation für Land- und Schiffs-Dampfturbinenanlagen). Felix Langen. The first instalment describes various systems of condensation. 1000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen —April 20, 1907. No. 84162 D.

Turbine Tests.

Tests of a 2000 Horse Power Riedler Steam Turbine (Versuche an einer 2000 Pferdigen Riedler-Stumpf-Dampfturbine). F. Rötscher. Describes the turbine which was coupled to a 1400-kw. asynchronous A. C. generator and gives the results of elaborate tests. Ills. 4500 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—April 20, 1907. No. 84144 D.

Valve Gears.

Valve Gears for Engines. P. E. Merriam. Illustrates and describes types of valves and valve gears and their adjustment. 1600 w. Engr, U S A—May 15, 1907. No. 84405 C.

Valve Gear for High-Speed Engines. A. Houlson. Investigates the method of determining the correct proportions of cylinders, valves, and valve gear for a modern high-speed vertical enclosed engine. Ills. 2400 w. Mech Engr—May 4, 1907. Serial. 1st part. No. 84336 A.

MISCELLANY.

Aeronautics.

The Future of Aerial Navigation (Die Zukunft der Luftschiffahrt). Georg Wellner. Describes several types of air ship and outlines the mathematical principles on which the design and construction of a successful air ship must be based. Diagrams. 4000 w. Zeitschr d Oest Ing u Arch Ver—April 26, 1907. No. 84181 D.

Capt. Ferber's Aëroplane Experiments. Illustrates the apparatus and describes the experiments of this French aëronaut. 900 w. Sci Am—April 13, 1907. No. 83579.

The Aero Club's Exhibit at the Agricultural Hall. Illustrates and describes some of the models shown. 2500 w. Auto Jour—April 13, 1907. Serial. 1st part. No. 83865 A.

The Development of the Air-Ship Motor (Die Entwicklung der Motor Aëronautik). Walter Oertel. Description of a large number of aeronautic motors. Serial. 4500 w. First part. Zeitschr d Mitteleuropäischen Motorwagen Vereins—No. 5, March, 1907. No. 83655 D.

Aeroplane Model Trials. An illustrated account of the competitive trials at the Alexandra Palace, April 15, 1907. 2200 w. Auto Jour—April 20, 1907. No. 83985 A.

Aerial Navigation. Major B. F. S. Baden-Powell. Considers the importance of the subject, discussing some of the general principles of aerodynamics, and stating facts in regard to recent machines. Also discussion. 7000 w. Jour Soc of Arts—April 19, 1907. No. 83982 A.

Adding Machine.

The Burroughs Adding and Listing Machine. Illustrates and describes an efficient adding machine used extensively in banks and clearing houses. 3500 w. Engng—May 3, 1907. No. 84342 A.

Air Flow.

The Flow of Air in Long Tubes with Special Reference to Pneumatic Dispatch. B. C. Batcheller. Formulae expressing the flow of air in tubes, illustrated by examples. 2500 w. Compressed Air—April, 1907. Serial. 1st part. No. 83952.

Dry Air.

Properties of Dry Air (Vom Trocknen). Otto Marr. Physical and chemical properties of air having different degrees of temperature and water vapor. Diagrams and tables. Serial. First part. 3300 w. Gesundheits Ingenieur—Dec. 8, 1906. No. 83665 D.

Liquefaction.

Machines for the Making of Liquid Air (Les Machines pour la Liquéfaction de l'Air). H. Demierre. General discussion of the problem of liquifying air and description of the Linde and Hampson machines. Ill. 2600 w. Bull Tech d l Suisse Rom—April 10, 1907. No. 83674 D.

The Liquefaction of Gases. Roger Baldwin Colton. Brief review of the progress made and the methods used. Ills. 1500 w. Yale Sci M—April, 1907. No. 83919 C.

Mechanics.

The Lack of Clearness in Some of the Fundamental Principles of Theoretical Mechanics (Mangelnde Klarheit in einigen Grundbegriffen und Principien der Theoretischen Mechanik). Karl Rudolf. The first part discusses the theory of rotating bodies with reference to centrifugal force. Ills. 2700 w. Serial. 1st part. Elektrotech u polytech Rundschau—April 10, 1907. No. 84169 D.

Oxygen.

The Manufacture of Oxygen. An account of the plant of the British Oxygen Company, with illustrations, especially describing the Linde liquid-air plant installed. 2000 w. Engng—April 19, 1907. No. 84001 A.

Seamless Tubing.

An Important Seamless Tubing Decision. Gives the decision sustaining the Shelby Steel Tube Co. in regard to the original Stiefel piercing mill. 3500 w. Ir Age—April 4, 1907. No. 83435.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

Coal Analysis from the Commercial Point of View. J. T. Dunn. Outlines the principles of methods of analysis, showing how far the results give the desired information, and gives related matter of interest. 3500 w. Col Guard—May 10, 1907. Serial. 1st part. No. 84441 A.

Breaker.

Breaker of the Pacific Coal Company in Alberta. Lewis Stockett and B. R. Warden. Plan, sections and description of this recently erected breaker for the preparation of anthracite coal. 2700 w. Eng & Min Jour—May 4, 1907. No. 84219.

Coal Washing.

Some Principles of Coal Washing. Classifies and discusses the impurities found in coal and methods of removing them; the significance of settling laws with reference to coal-washing; coal-washing devices, etc. Ills. 6000 w. Can Min Jour—May 15, 1907. No. 84401.

The Production of Coke and Its Application in Domestic Fires. Paul Schlicht. Considers the use of bituminous coal, the production of coke, kinds of coke, its application in domestic fires, and illustrates and describes a new method of combustion. Discussion follows. 11000 w. Jour Soc of Arts—May 10, 1907. No. 84431 A.

Conveyors.

Conveyor-System for Loading at the Coal-face. Floyd W. Parsons. Explains this method of operation and its advantages. 1500 w. Eng & Min Jour—May 18, 1907. No. 84423.

Disaster.

The Warrior Run Mine Disaster. Charles Enzian. Describes methods used in combatting a mine fire accompanied by a squeeze and large quantities of explosive gas. 6000 w. Mines & Min—May, 1907. No. 84062 C.

Electric Power.

Electric Power in Durham Collieries. An illustrated article giving details of the power house equipment and a description of colliery plant. 1500 w. Elec Rev, Lond—April 26, 1907. Serial. 1st part. No. 84246 A.

Electrification of the Lambton Collieries. Illustrates and describes a plant of the alternate-current type. 2400 w. Ir & Coal Trds Rev—May 3, 1907. No. 84350 A.

Colliery Hoisting, Haulage and Power Systems. Franz Erich Junge. Compares the cost of individual steam-driven hoist and power units with that of the central electric power-station system. 4000 w. Eng & Min Jour—May 11, 1907. No. 84313.

Germany.

The Coal District Northeast of the Ruhr as Disclosed by Borings and Comparison with the Cardiff District (Das Steinkohlengebiet nordöstlich der Roer nach den Ergebnissen der Tiefbohrungen und verglichen mit dem Cardiff-Distrikt). Drs. Krusch and Wunstorf. The geology of this district, stratigraphy as disclosed by numerous borings and comparison with the South Wales fields. Plates. 8000 w. Glückauf—April 13, 1907. No. 84151 D.

Comparison Between the Roer Coalfield and the Cardiff District. Krusch and Wunstorf, in *Glückauf*. Map. With descriptive comparison. 1100 w. Col Guard —May 3, 1907. No. 84339 A.

Haulage.

Shunting Railway Wagons by Ropes. James Tonge. Describes the Heckel shunting system, in which the work is done by an endless wire rope which runs parallel to the rails. 900 w. Ir & Coal Trds Rev—May 3, 1907. No. 84349 A.

Mechanical Haulage Arrangements at the Pit Head of Shaft II. of the Neumühl Mine (Die mechanische Förderungsanlage an der Hängebank von Schacht II der Zeche Neumühl). Herr Stapff. Illustrated detailed description of an arrangement which handles the cars from the cage to their final destination. 2000 w. Glückauf—April 6, 1907. No. 84150 D.

Rescue Apparatus.

New Breathing Apparatus (Neuerungen an Atmungsapparaten). Herr Grahn. New types of rescue apparatus are illustrated and described. 1800 w. Glückauf —April 20, 1907. No. 84152 D.

Sampling.

Coal Sampling. Dr. J. E. Woodman. Read before the Nova Scotia Min. Soc. Aims to show the results of work done in connection with the U. S. Geol. Surv. testing plants at St. Louis. 2500 w. Can Min Jour—May 1, 1907. No. 84087.

Spontaneous Combustion.

The Spontaneous Combustion of Coal Fields and Alteration of Overlying Strata. A. Lakes. Describes remarkable changes in the Colorado coal fields caused by intrusions of igneous or eruptive rocks, or by spontaneous combustion. 800 w. Min Rept—May 2, 1907. No. 84200.

Storage.

See Civil Engineering, Construction.

COPPER.

British Columbia.

Methods of Mining in the Boundary District, British Columbia. Frederic Keffer. Describes recent low-cost systems which have made possible the profitable mining of low-grade copper ores. Ills. 2800 w. Engineering Magazine—June, 1907. No. 84199 B.

Copper Mining an Important Industry in British Columbia. E. Jacobs. An illustrated review of the development and progress at various camps, with statistics of production, etc. 7000 w. B C Min Rec—March, 1907. No. 84265 B.

Desulphurizing.

The McMurtry-Rogers Process for Desulphurizing Copper Ores and Matte. T. C. Cloud. Describes the treatment of ore by this process. 5000 w. Inst of Min & Met, Bul 31—April 11, 1907. No. 84013 N.

Extraction.

New Electrolytic Process for Extraction of Copper from Ore. W. Stoeger. Trans. from *Rev. d'Electrochimie et d'Electrometallurgie*. Describes the Larszcynski process and its industrial application. 1700 w. Min Jour—April 27, 1907. No. 84251 A.

Smelting.

The Chief Advances in Copper Smelting in Modern Times. William Gowland. Presidential address. Considers the increase in the production of copper and the means by which it has been brought about. Ills. 10000 w. Inst of Min & Met, Bul 31—April 11, 1907. No. 84011 N.

Some Paradoxes of Matte Smelting. David H. Browne. Calls attention to some curious things observed in matte smelting. 1500 w. Can Min Jour—May 1, 1907. No. 84085.

Chrome Plant of U. S. Metals Refining Company. Lawrence Addicks. Illustrated description of a new copper-smelting plant and electrolytic refinery in course of construction. 3000 w. Eng & Min Jour—May 25, 1907. No. 84572.

The Copper-Smelting Works at Humboldt, Ariz. E. H. Hamilton. Illustrated description of the plant of the Arizona Smelting Co. which is electrically driven and employs fuel-oil furnaces. 1500 w. Eng & Min Jour—May 11, 1907. No. 84314.

Utah.

Mining at Bingham, Utah. James W. Abbott. An illustrated account of this camp worked at first for gold, silver and lead, but finally developing into a great copper mine. 1500 w. Min & Sci Pr—May 11, 1907. No. 84367.

GOLD AND SILVER.

Assaying.

Some Experiences in Assaying Telluride Ores. J. N. McLeod. Reports assays of ores containing either high percentages of tellurium, or tellurium with other metals, which apparently had a marked effect on the results. 1800 w. Min Wld—May 18, 1907. No. 84411.

The Screen Assay on the Meyer and Charlton G. M. Under "The New Metallurgy." Chris Toombs. Reports results obtained by screen assay in the presence of cyanide solution. 2000 w. Jour Chem, Met & Min Soc of S Africa—March, 1907. No. 84432 E.

Battery Foundations.

Battery Foundations of the Kuk-San-Dong Mill, Korea. Charles D. Kaeding. Illustrates and describes concrete mortar piers and battery foundations of a somewhat unusual type. 600 w. Min & Sci Pr—May 11, 1907. No. 84368.

Black Sands.

The Auriferous Black Sands of California. J. A. Edman. Introductory remarks, with a statement of the origin, distribution and probable values of the heavy black sands on the Pacific Coast, from the standpoint of the miner and metallurgist. 2200 w. Min Rept—May 2, 1907. No. 84201.

Cobalt.

Cobalt. An account of the geology of the region and of the number and extent of development of the principal mines. Ills. 4000 w. Mines & Min—May, 1907. Serial. 1st part. No. 84065 C.

Colorado.

The Joker Drainage Tunnel. R. L. Herrick. An account of this once famous mining region, explaining the causes for the cessation of mining, reviewing the geology and describing the reopening of the mines, tunnel driving, etc. The district contains silver, lead and copper ores and other minerals of value. Ills. 5000 w. Mines & Min—May, 1907. No. 84067 C.

Concentration.

The Hercules Mill. Scott Turner. Describes this most recent concentrating plant of the Cour d'Alene region, as typifying the most approved lead-silver milling methods in northern Idaho. 3000 w. Min & Sci Pr—May 4, 1907. No. 84306.

The Sherman Concentrating Table. C. Everard Arnold. Sketch, plan and description. 600 w. Min & Sci Pr—May 11, 1907. No. 84369.

Elmore Process.

Ore Concentration by Oil. Diagram and description of the process invented by F. E. Elmore, with illustrations. 1600 w. Engr, Lond—May 10, 1907. No. 84448 A.

Vacuum-Flotation Process for Concentration. Alexander Stanley Elmore. Describes the method of operation of the Elmore process which employs reduced pressure to increase by expansion the lifting power of gas bubbles in a liquid medium. 1200 w. Eng & Min Jour—May 11, 1907. No. 84316.

Honduras.

Mining in Honduras. Horace G. Nichols. Describes the character of the deposits, methods of mining, labor, etc. Gold and copper and other minerals of value are found. Ills. 3000 w. Min & Sci Pr—May 11, 1907. No. 84370.

Idaho.

The Gold of the Snake River. Robert N. Bell. A detailed description of these low-grade deposits. Ills. 1500 w. Min & Sci Pr—April 27, 1907. No. 84091.

The Murray Gold Belt, Idaho. Theo. L. Lammers. Describes the formation of this district, the deposits, and gives an account of the development. 1600 w. Min & Sci Pr—May 18, 1907. No. 84602.

Mexico.

History and Development of Batopilas Mine, Mexico. Stuart Tod. Outlines the early history of this silver mine, and its present condition. Ills. 3000 w. Min Wld—May 4, 1907. No. 84237.

Metallurgical Development at Guanajuato. T. A. Rickard. An illustrated description of the reduction works at the Sirena mill, with an account of their development. 2500 w. Min & Sci Pr—May 18, 1907. No. 84600.

Mines and Prospects of Sierra Almoloya. Robert Thomas Hill. An account of the Cigarrero Mine, and of the Iguana Mine, in the Almoloya mountain district of Mexico. Ills. 1000 w. Min Wld—May 4, 1907. No. 84232.

The Dolores Mine, Chihuahua, Mexico. John B. Farish. Section and description of the veins and the development. 500 w. Eng & Min Jour—May 4, 1907. No. 84216.

The Geology of the Veta Madre. T. A. Rickard. Gives plan and sections of the Veta Madre, with description of the rich silver deposits. 3500 w. Min & Sci Pr—April 27, 1907. No. 84090.

Mines.

The Great Gold Mines. T. A. Rickard. Some facts in regard to the leading gold mines of the present day, their productiveness, and ore values. Considers the Robinson, in the Transvaal, the greatest gold mine yet worked. 2500 w. Min & Sci Pr—May 4, 1907. No. 84305.

Nevada.

The Renaissance of Nevada. Remarks on the recent revival of mining in the deserts of Nevada, the leading features in the development, the deposits of gold, silver and copper, etc. 2000 w. Min & Sci Pr—May 4, 1907. No. 84307.

The Gold Mountain District, Nevada. F. L. Ransome. Describes this district and the gold and silver ores, and the principal mines. 1500 w. Min Rept—May 2, 1907. No. 84202.

Placers.

British Columbia Placers: Past and Present. Horace F. Evans. Interesting information concerning the early placer mining of British Columbia. 1800 w. Min Wld—May 4, 1907. Serial. 1st part. No. 84234.

Placer Dredging in California. George L. Holmes. An illustrated account of the development and success of this industry, showing types of dredges used. 1600 w. Min Wld—May 25, 1907. No. 84603.

Gold Dredging in Europe (Die Goldbaggerie in Europa). L. St. Rainer. Read before the Mining and Metallurgical Section of the Austrian Society of Engineers and Architects. Discusses the gold-bearing streams and the dredging operations. 2800 w. Serial. 1st part. Oest Zeitschr f Berg und Hüttenwesen—April 27, 1907. No. 84136 D.

Russia.

A Visit to the Gold Fields of Orenburg, Russia. F. H. Hatch. Describes peculiarities of this district, noticed during recent travels. 2200 w. Inst of Min & Met, Bul 31—April 11, 1907. No. 84012 N.

IRON AND STEEL.

Assaying.

A Method for the Estimation of Iron in Presence of Titanium. F. A. Gooch and H. D. Newton. Describes an investigation undertaken for the purpose of adapting the ordinary process of reducing the ferric salt by zinc to the estimation of iron in presence of titanium. 700 w. Am Jour of Sci—May, 1907. No. 84016 D.

Determination of Silica and Alumina in Iron Ores. Graham W. Dean. Gives the method of procedure when silica only is required, and also when alumina is required. 2000 w. Min Wld—May 11, 1907. No. 84308.

Blast Furnaces.

The Blast Furnace Practically and Theoretically Considered. W. J. Foster. Read before the Saffordshire Ir. & St. Inst. An examination of the processes involved in working a blast furnace. 5500 w. Ir & Coal Trds Rev—April 19, 1907. No. 84009 A.

The Application of the Centrifugal Dust Collector to the Blast Furnace. Frank C. Roberts. Briefly reviews the development of devices for the removal of dust and dirt from the waste gases of the blast furnace and gives results obtained by the use of the centrifugal dust collector. 1400 w. Ir Trd Rev—May 9, 1907. No. 84270.

Charging Machines.

Machines for Charging Metallurgical Furnaces (Machines à Charger les Fours Métallurgiques). Ch. Dantin. Illustrated description of machines for charging Martin furnaces and machines for handling ingots and ingot moulds. 2500 w. Génie Civil—April 20, 1907. No. 84115 D.

Electric Power.

Electric Power in Iron and Steel Works. D. Selby Bigge. Read before the Ir. & St. Inst. On the development of electricity in the iron and steel industries, with special reference to its latest application to reversing rolling mills of high power. Explains the advantages and points of special interest, giving a description of the Hildegarde Works. Ills. 8500 w. Engng—May 10, 1907. No. 84447 A.

The Development of Electricity in the Iron and Steel Industries, with Special Reference to Its Latest Application to Reversing Rolling Mills of High Power. D. Selby Bigge. Illustrations and diagrams. 8500 w. Ir & Coal Trds Rev—May 10, 1907. No. 84612 A.

The Electric Power Installation at Grangesberg Iron Mines, Sweden. G. Ralph. Abstract of a paper read before the Newcastle Loc. Sec. of Inst. of Elec. Engrs. A descriptive article, with illustrations. 2500 w. Ir & Coal Trds Rev—May 3, 1907. No. 84348 A.

Electric Smelting.

Preliminary Report on the Experiments on the Electric Smelting of Canadian Iron Ores, Carried Out Under Government Auspices at Sault Ste. Marie (Vorläufiger Bericht über die in Sault St. Marie unter dem Protektorat der Regierung angestellten Versuche zur Schmelzung Kanadischer Eisenerze Vermittels der Elektrothermischen Methode). Dr. Eugen Haanel. Ills. 1200 w. Serial. 1st part. Elektrochem Zeitschr—April, 1907. No. 84132 G.

Great Britain.

The Iron Ore Supplies of Great Britain. T. Good. A discussion of the British iron ore resources, claiming there are vast reserves available. 2500 w. Cassier's Mag—May, 1907. No. 84050 B.

Induced Draught.

Induced Draught, with Hot-Air Economizers, for Steel Works and Blast Furnace Boilers. A. J. Capron. Describes a system that has been in use for marine purposes for about ten years, and recently has been coming into extensive use for land boilers. Ills. 3000 w. Ir & Coal Trds Rev—May 10, 1907. No. 84616 A.

Ironstone.

The Ironstone of Cleveland. Arthur E.

Pratt. Describes the geology and mining methods, and the calcination. 4500 w. Inst of Min & Met, Bul 31—April 11, 1907. No. 84015 N.

Iron Works.

The Works of the Atikokan Iron Company, Limited. Illustrates and describes the new blast furnace, ore roasting kilns, and coking plant at Port Arthur, Ontario. 1500 w. Ir Age—May 2, 1907. No. 84029.

Magnetic Separation.

Magnetic Separation of Iron Ore in Sweden. G. Walfrid Petersson. Illustrates and describes methods and machines used. Twenty-one plants are in operation, producing concentrates containing 63 to 65 per cent. iron from ore carrying 25 to 30 per cent. 4500 w. Eng & Min Jour—May 11, 1907. No. 84312.

Malleable Iron.

Manufacture of Malleable Iron. G. A. Akerlind. Read before the Scandinavian Tech. Soc., Chicago. A review of the manufacture, physical properties, and treatment. 3000 w. Foundry—May, 1907. No. 84057.

Open Hearth.

A Modern Acid Open Hearth Steel Casting Plant. Illustrated detailed description of the new department of the National Foundry Co., Erie, Pa. 2200 w. Foundry—May, 1907. No. 84056.

Cost of Equipping Open Hearth Steel Foundries. W. M. Carr. Gives an estimate made on the basis of daily capacity. 800 w. Foundry—May, 1907. No. 84059.

Production.

Diagram of the Processes and Products of Iron and Steel Manufacture. Albert Sauveur. Gives a diagram drawn by H. M. Boylston, of Harvard University, outlining the information it yields. 1200 w. Ir Trd Rev—May 9, 1907. No. 84271.

Retort Charging and Discharging Machine. Illustrated description of a machine for use in connection with continuous horizontal retorts having two mouths. 800 w. Engr, Lond—April 19, 1907. No. 84008 A.

Steel Making.

A Method of Producing High-Class Steel from Pig-Iron Containing Chromium, Nickel and Cobalt. Arthur Windsor Richards. Gives a detailed description of the process. 1500 w. Ir & Coal Trds Rev—May 10, 1907. No. 84614 A.

The Manufacture of Steel from High-Silicon Phosphoric Pig-Iron by the Basic Bessemer Process. Arthur Windsor Richards. Describes the process in use at the Cleveland Works for blowing in the basic converter iron which is high in silicon and low in phosphorus. 1500 w. Ir & Coal Trds Rev—May 10, 1907. No. 84613 A.

The Relation Between the Process of Manufacture and Some of the Physical Properties of Steel. F. W. Harbord. Gives tabulated results from experimental bars and other sources, with report of tests. 2200 w. Ir & Coal Trds Rev—May 10, 1907. No. 84615 A.

Würtemberg,

The Iron-Ore Deposits and Iron Industry in Würtemberg (Die Eisenerzlagerstätten und die Eisenindustrie Würtembergs). C. Geiger. Information compiled from the Würtemberg Statistical Annual. Map. 2800 w. Stahl u Eisen—April 24, 1907. No. 84131 D.

MINING.

Air Compressors.

Portable Electric Air Compressors. Frank C. Perkins. Illustrated description of machines used to obtain the advantages of electric transmission and of compressed air operation for mining machinery. 1200 w. Mines & Min—May, 1907. No. 84064 C.

Bore-Holes.

Camera for Photographing Walls of Bore-Holes. J. T. Atwood. Illustrated description of a camera and the method of operation, for obtaining views of a continuous strip of the formations pierced by the drill, showing the character and distribution of the ore. 1500 w. Eng & Min Jour—May 18, 1907. No. 84420.

Car Handling.

Handling Cars with Rolling Device for Dumping. Erskine Ramsay. Illustrates and describes a car-handling and dumping device used at many American mines, stating its advantages. 1500 w. Eng & Min Jour—May 11, 1907. No. 84317.

Compressed Air.

Compressed Air in Mining. J. H. Hart. Remarks on the efficiency and economy of falling-water compressors, explaining their operation. 900 w. Eng & Min Jour—May 4, 1907. No. 84218.

Drainage Tunnel.

The Cripple Creek Drainage Tunnel and Its Significance in Scientific Mining. Victor C. Alderson. Abstract of an address delivered at the inauguration of the driving of the deep drain tunnel. 3300 w. Min Rept—May 16, 1907. No. 84410.

Examination.

The Examination of Mining Properties (Die Begutachtung von Bergwerksunternehmungen). Otto Pütz. Discusses the various factors which should enter into a decision of the value of a mining property. 2300 w. Glückauf—April 27, 1907. No. 84154 D.

Grinding Machines.

Machines for Grinding Chalk, Cements, Phosphates and Similar Materials (Appareils de Broyage pour Chaux, Ciments, Phosphates et Matières Analogues). P.

Chignaterie. Illustrated description of various types with plate showing sections of mills. 3000 w. Génie Civil—April 20, 1907. No. 84116 D.

Mine Locomotives.

The Prevention of the Risk of Fire in the Use of Benzol Mine Locomotives (Die Verhütung der Brandgefahr bei Benzol Grubenlokomotiven). Herr Russell. Illustrates and describes this type of locomotive and safe ways of storing and using benzol underground in coal mines. 2000 w. Glückauf—April 27, 1906. No. 84153 D.

Mine Timber.

Preservation of Mine Timber. John M. Nelson. Gives conclusions from experimental work, with various methods of treatment and the cost. Ills. 1200 w. Min Wld—May 25, 1907. No. 84604.

The Preservation of Mine Timber from Decay. An account of experiments made with different preservatives and different methods of applying, with a comparison of costs. Ills. 1200 w. Mines & Min—May, 1907. No. 84066 C.

Montana.

Annual Address. Bertram H. Dunshee. Presidential address, considering recent improvements in the mining and treatment of ores, especially in Montana. 9000 w. Jour Assn of Engng Socs—April, 1907. No. 84526 C.

Ore Deposition.

Effect of Wall Rock on the Deposition of Ore. G. W. Miller. Observations on the geology of the metal-bearing veins of Silver Mountain and vicinity in the San Juan region of Colorado. 1700 w. Ores & Metals—May 20, 1907. No. 84452.

Philippines.

Mines and Minerals in the Philippines. Thornton Chase. A report of rich deposits of coal, iron, copper, lead and gold. 1200 w. Eng & Min Jour—May 4, 1907. No. 84217.

Power Plant.

The Electrical Equipment of the Yak Tunnel. Robert E. Renz. Illustrates and describes the plant which supplies current for the operation of the tunnel, for mining in adjoining properties, and for lighting and power. 2000 w. Eng & Min Jour—May 25, 1907. No. 84570.

Prospecting.

Prospecting in Ungava. J. C. Murray. Begins an illustrated description of this portion of the Labrador peninsula. 1800 w. Serial. 1st part. Can Min Jour—May 1, 1907. No. 84086.

Pumping.

Mine Pumping with Direct Connected Electrically Driven Turbine Pumps. P. H. Moore. Read before the Nova Scotia Min. Soc. An account of the writer's experience with turbines in the Micmac Mines, Nova Scotia, describing the plant. 2800 w. Can Min Jour—May 1, 1907. No. 84088.

Safety Lamp.

The Wolf Safety Lamp. L. H. Hodgson. Illustrates and describes this lamp, showing its efficiency. 1000 w. Eng & Min Jour—May 18, 1907. No. 84424.

Shafts.

Sinking the Allan Shafts. H. E. Coll. Read before the Nova Scotia Min. Soc. Describes the equipment, sinking operations, method of timbering, etc. 3800 w. Can Min Jour—May 1, 1907. No. 84084.

South America.

Colombia; Its Resources and Its Development. J. T. O'Brian. Information gathered during several years of research. Reports fertile lands, favorable climate, inexhaustible forests, mining prospects of promise, great natural wealth almost undeveloped. 2500 w. Min Wld—May 25, 1907. No. 84605.

Stoping.

Stoping Systems at Broken Hill, Australia. A. J. Moore. Illustrates and describes methods devised to meet the conditions encountered in mining large bodies of sulphide ores. 4200 w. Mines & Min—May, 1907. No. 84061 C.

Subsidence.

Mine Subsidence. Alex. Richardson. Gives conclusions reached from a study of the surface effects of subsidence, giving diagrams showing the caving of various mines, discussing methods of protection and the subject in general. 4200 w. Jour Chem, Met & Min Soc of S Africa—March, 1907. No. 84433 E.

MISCELLANY.

Asbestos.

Asbestos. An illustrated article discussing the commercial aspects and giving general information of the asbestos industry. Also The Canadian Asbestos. Fritz Cirkel. A review of progress. Ills. 3000 w. Can Min Jour—May 15, 1907. No. 84400.

Cobalt.

Cobalt: Its Occurrence and Uses. Joseph Hyde Pratt. Information concerning this mineral and its uses, and localities in North Carolina where it has been found. 1500 w. Min Wld—May 4, 1907. No. 84235.

Graphite.

Canadian Graphite. H. P. H. Brunnell. Abstract of a paper read before the Can. Min. Inst. Gives information concerning the ore deposits, milling, etc. 1200 w. Min Wld—May 18, 1907. No. 84412.

Separating Graphite on Molybdenite. James Francis Latimer. An account of an invention for an improved process for separating and refining of graphite from graphite material, and molybdenite and other minerals from their gangue. Ill. 1500 w. Min Wld—May 18, 1907. No. 84413.

Illinois.

The Work of the State Geological Survey. H. Foster Bain. An account of what has been done, and the work proposed, in the geological survey of Illinois. Map. Discussion. 7000 w. Jour W Soc of Engrs—April, 1907. No. 84531 D.

Lead.

A Curious Deposit of Cerussite in Colorado. Robert B. Brinsmade. Describes an unusual deposit in the Terrible Mine, at Ilse, Custer Co. It is not associated with sulphides and other minerals usually found with lead. 1200 w. Eng & Min Jour—May 4, 1907. No. 84215.

Lead Refining.

See Electrical Engineering, Electro-Chemistry.

Mercury.

Electro Determination of Mercury and Its Separation from Silver. Henry Julius Solomon Sand. Abstract of a paper from *Jour. of Chem. Soc.*, London. Describes experimental investigations. 1000 w. Min Rept—April 25, 1907. No. 84017.

Ore-Dressing.

Developments in Ore-Dressing (Fortschritte in der Erzaufbereitung). Ulrich Horel. Illustrated description of several of the latest ore-dressing tables. 2500 w. Oest Zeitschr f Berg und Hüttenwesen—April 20, 1907. No. 84135 D.

Petroleum.

Petroleum and Its Refinement. Prof. Charles E. Munroe. An illustrated account of this product and the methods used for its purification and refinement. 6000 w. Sci Am Sup—May 4, 1907. No. 84083.

Phosphate.

Phosphate Rock in Utah, Idaho, and Wyoming. Charles Colcock Jones. Describes these deposits. Ills. 2000 w. Eng & Min Jour—May 18, 1907. No. 84422.

Sodium Nitrate.

The Sodium Nitrate Deposits of the Colorado. H. W. Turner. Describes these deposits, reporting examinations made in four localities. Map. 1200 w. Min & Sci Pr—May 18, 1907. No. 84601.

Sulphur.

Determination of Sulphur in Pyrite. Henry Fay. Describes the methods of Lunge, and of Fresenius, with notes. 2200 w. Tech Qr—March, 1907. No. 84472 E.

Tin.

The Tin-Mining Industry of Cornwall. Illustrated description of the mining and treatment of the ore, the revival of the industry, and improved methods. 2200 w. Sci Am Sup—May 4, 1907. No. 84082.

The Tin-Stream Works of Red River, Cornwall. Edward Walker. Explains the treatment of tailings over and over again by twelve to twenty operators. Ills. 1200 w. Eng & Min Jour—May 25, 1907. No. 84571.

Tin Ore Dressing. J. B. Hill and D. A. MacAlister. Illustrates and describes the more important appliances actually in use in the mines of the Camborne district in West Cornwall, England. 1200 w. Min Wld—May 11, 1907. Serial. 1st part. No. 84309.

Tin Ore Dressing Plant, East Pool, Cornwall. Edward Walker. Illustrates and describes the reconstructed Tolvadden ore-dressing plant where tin oxide, wolframite, arsenical and copper pyrites are separated by stamps, concentrating tables, calciners and magnetic separators. 1500 w. Eng & Min Jour—May 18, 1907. No. 84419.

The Smelting of Tin Slags. L. Parry. Explains the principles underlying the cleaning of tin slags, the recovery of the tin, especially a lead concentration process patented by the writer. 3000 w. Min Jour—April 27, 1907. No. 84250 A.

Tungsten.

The Panasqueira Tungsten District, Portugal. Wilhelm Preus. Describes the location, mineralization, etc. Map. 800 w. Eng & Min Jour—May 4, 1907. No. 84214.

The Tungsten Deposits of Boulder County, Colo. William E. Greenawalt. Describes an old gold and silver camp which now produces more than 80 per cent. of the tungsten of the United States. 1500 w. Eng & Min Jour—May 18, 1907. No. 84421.

The Rare Minerals: Their Present Industrial Status. Edgar C. Riebe. Discusses principally the tungsten minerals, their uses, and the reasons for their slow development in the United States. 1200 w. Min Wld—May 4, 1907. No. 84236.

Underground Waters.

The Geological Relations of Water in the Graner Lignite Deposits (Die Wasserverhältnisse des Graner Braunkohlenreviers). Karl Stegl. The first instalment describes the floods which have occurred during the last thirty years in the mines of this Austrian coal field. Ills. 3000 w. Serial. 1st part. Oest Zeitschr f Berg und Hüttenwessen—April 13, 1907. No. 84134 D.

Volumetric Methods.

On Technical Volumetric Methods in General. V. H. Gottschalk. Read before the W. Assn. of Tech. Chem & Met. Discusses the nature of the chemical reaction employed; the nature of the indicator; dependence on conditions of titration; and proper manipulation of measuring instruments. 5000 w. Min Jour—May 18, 1907. No. 84576 A.

Zinc.

Production and Consumption of Spelter in 1906 Walter Renton Ingalls. Statistics of production and consumption of spelter and zinc ore. Ills. 3400 w. Eng & Min Jour—May 18, 1907. No. 84418.

Broken Hill Zinc Field, New South Wales. Ralph Stokes. Concerning the treatment by the Delprat process of the tailings from the Barrier ores, which are rich in zinc. Also the treatment of old tailings at the Central Mine by the magnetic method. Ills. 1500 w. Min Wld—May 4, 1907. No. 84233.

Zinc Oxide.

Zinc-Oxide and Zinc-Lead Pigment Manufacture. William F. Gordon. An illustrated article explaining how the process requiring pure zinc ores and anthracite fuel was made suitable for complex ores and the use of soft-coal and for saving the copper, gold and silver. 1400 w. Eng & Min Jour—June 1, 1907. No. 84705.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Government Accident Bulletin, No. 22. The report of the Interstate Commerce Commission for the three months ending Dec. 31, 1906. Also the the Virginia Commission report on the Lawyer collision. 4500 w. R R Gaz—May 24, 1907. No. 84539.

Derailment.

The Bronx Park Derailment on the New York Central: Report of the State Railroad Commission. Gives the findings and recommendations of this commission, with comments. 2000 w. Eng News—May 16, 1907. No. 84388.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Control on Heavy Grades of Trains Composed Exclusively of Fully Loaded 100,000 Lbs. Capacity Cars. T. L. Burton. From a paper read before the Air Brake Assn. Reports tests made which proved the ability of air brakes used exclusively to control a heavy train under severe conditions. 1000 w. R R Gaz—May 24, 1907. No. 84543.

S F 4, Pump Governor. Discusses some of the peculiarities in the operation of this pump governor which is designed to automatically adjust the relation of the brake pipe and the main reservoir pressure. 7000 w. Ry & Loc Engng—May, 1907. No. 84031 C.

Cars.

Combination Parlor, Sleeping and Dining Cars for the Canadian Northern. Illustrated description of the general arrangements and finish of these cars. 500 w. R R Gaz—May 3, 1907. No. 84079.

Dynamometer.

Portable Traction Dynamometer. E. N. Stacey and O. B. Bjorge. Illustrates and describes a dynamometer designed to measure tractive effort. 800 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84628 N.

Freight Cars.

Maintenance and Repair of Steel Freight Cars. An illustrated article considering the life of steel cars, their repair, liability to damage, their design, cost, etc., as reported by the Baltimore & Ohio Railroad. 10000 w. Am Engr & R R Jour—May, 1907. No. 84092 C.

Composite Hopper Car. Illustrated description of cars of 85,000 lbs. capacity for the Delaware & Hudson Company. 700 w. Am Engr & RR Jour—May, 1907. No. 84095 C.

Historical Address.

Address by the President, T. Hurry Riches. Brief discussion of railway rolling stock, and machinery. Many illustrations. 4000 w. Inst of Mech Engrs—April 25, 1907. No. 84478 N.

Locomotives.

The Modern Locomotive. Paul T. Warner. Discusses the features of modern locomotives which have made possible the meeting of present day demands, giving brief illustrated descriptions of some of the engines. 6000 w. Jour Fr Inst—May 1, 1907. No. 84551 D.

An Interesting Order of Locomotives. Illustrates and describes the ten locomotives for the Central Railroad of Brazil. Six are of the consolidation type, two of which are equipped with Baldwin superheaters; two are single expansion 10-wheel locomotives fitted with Vaughan superheaters, and two are 10-wheel type with balanced compound cylinders. 1400 w. Ry Mas Mech—May, 1907. No. 84269.

Petrol Electric (Mixed Traction) Locomotive on the Belgian State Railways for Shunting Goods Wagons. Em. Uylborck.

An illustrated description of the mixed traction locomotive on the Pieper system. Its principal components are an internal combustion engine, a continuous-current dynamo, and a battery of accumulators. 3000 w. Bul Int Ry Cong—April, 1907. No. 84521 E.

An Italian Balanced-Compound Passenger Locomotive with Cab in Front. Illustrates and describes a peculiar design introduced extensively on the Adriatic lines of the Italian State Rys., with report of service. 1500 w. Eng News—May 23, 1907. No. 84498.

Italian Balanced Compound Locomotive. Illustrated detailed description of a high-powered "Prairie" type engine for fast passenger trains. 1500 w. Engr, Lond—April 19, 1907. No. 84006 A.

Compound Locomotive, St. Gothard Railway. Illustrated description of an engine recently built for the most difficult service on this line. 700 w. Engr, Lond—May 17, 1907. No. 84584 A.

Standard Locomotives of the Midland Railway. Illustrates four of the standard freight and passenger locomotives in use on this English railway, giving descriptions and tractive power. 1200 w. R R Gaz—May 24, 1907. No. 84541.

Simple Consolidation Locomotive. Illustrated description of heavy single expansion freight engines built for the Colorado Southern, New Orleans and Pacific Railroad. 800 w. Am Engr & R R Jour—May, 1907. No. 84096 C.

Decapod Locomotive for the Buffalo, Rochester & Pittsburg. Elevation, sections, and description of the heaviest simple engines ever built for pushing service. 900 w. Ry Age—May 10, 1907. No. 84285.

Four-Cylinder Simple Ten Wheel Locomotive. Charles S. Lake. Illustrates and describes a type of powerful high speed locomotives in service on the London & Southwestern Railway. 2000 w. Am Engr & R R Jour—May, 1907. No. 84094 C.

The Four Cylinder Balanced Compound in Actual Service. H. A. F. Campbell. Presents records made by 4-cylinder balanced compound Atlantic locomotives in actual service. 4000 w. Ry Mas Mech—May, 1907. No. 84266.

High-Power Articulated Locomotives in the United States (L'Emploi de Locomotives Articulées de Grande Puissance aux Etats-Unis). M. Japiot. Describes the Mallet locomotives in use on the Baltimore & Ohio, Great Northern, and Erie Railroads. Ill. 6000 w. Rev Gén des Chemins de Fer—April, 1907. No. 84110 G.

Road Performance of Mallet Compound Locomotives. A report of these engines for helper service on the mountain divisions of the Great Northern Railroad. 800 w. Ry Mas Mech—May, 1907. No. 84267.

Rack Locomotive for the Trans-Andine Railway. Describes the line on which these engines are to be used, and gives an illustrated description of the locomotives. Plate. 1500 w. Engng—May 17, 1907. No. 84578 A.

Locomotive Tests.

Analysis of Locomotive Tests. Sidney A. Reeve. Gives analyses made to ascertain what proportions of heat developed within a locomotive boiler were absorbed by the earlier and later portions of the heating surface, or by fire-box and tubes, or were lost up the stack. The St. Louis tests formed the basis for the investigation. 1200 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84643 F.

Locomotive Performance Data Developed at Purdue. Editorial review of valuable information obtained from this testing plant. 1700 w. R R Gaz—May 3, 1907. No. 84073.

Motor Cars.

European Railway Motor Cars. B. D. Gray. Illustrates and describes types of self-propelled cars used abroad, and gives the author's impressions of the railway motor car situation. 5400 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84642 F.

Gasoline Motor Cars for Railway Service. W. R. McKeen, Jr. Discusses the design of such cars, the engine, cost of operation, etc. General discussion. Ills. 14500 w. Pro N Y R R Club—April 19, 1907. No. 84482.

Pennsylvania Report on Motor Cars. Extracts from report of a special committee appointed to study the operation of foreign road and rail motor cars. 3500 w. R R Gaz—May 3, 1907. No. 84075.

Stokers.

Mechanical Stokers for Locomotives. George S. Fowler. States the requirements of such stokers, and gives plans and description of the Victor stoker and the Hayden stoker. 3000 w. Cassier's Mag—May, 1907. No. 84054 B.

Superheated Steam.

See Mechanical Engineering, Steam Engineering.

Train Lighting.

Electric Train Lighting. O. W. Ott. Discusses briefly the three principal systems on the lighting of trains by electricity, the cost, maintenance, etc. General discussion. 11500 w. Pro W Ry Club—April 16, 1907. No. 84484 C.

Vibrations in Passenger Trains from High Speed Electric Lighting Engines. F. W. Huels. Gives results of tests made to measure the magnitude and character of these vibrations, describing methods and instruments used. Discussion. Ills.

7000 w. Jour W Soc of Engrs—April, 1907. No. 84530 D.

Car Lighting. Ed. Wilhelm. Principally an explanation of the advantages of Pintsch gas. General discussion. 3000 w. Pro Iowa Ry Club—April 12, 1907. No. 84481 C.

Valves.

Locomotive Piston Valves. Hal R. Stafford. Gives a brief account of the earlier applications of the piston valve to the locomotive, and discusses their advantages and disadvantages. Ills. 3000 w. Am Engr & R R Jour—May, 1907. No. 84093 C.

NEW PROJECTS.

Chicago.

Improvements on the Chicago Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry. Maps, profiles, and descriptive account of extensive improvements, including various kinds of work. Also editorial. 6000 w. Eng News—May 16, 1907. No. 84386.

Florida.

Construction of Florida East Coast Railway. Allen Hale. Illustrates and describes interesting phases of this remarkable railroad. 1500 w. Sci Am—May 18, 1907. No. 84392.

N. Y. C. & H. R. R. R.

New York Central & Hudson River. Discusses the improvements made during 1906 and 7, the electrification, improved stations, increase in earnings and related matters. 1800 w. R R Gaz—May 3, 1907. No. 84074.

Oregon.

Line Changes and Extensions of the Oregon Railroad & Navigation Company's System in Oregon and Washington. W. P. Hardesty. An illustrated account of work recently completed, still under way or authorized. 3500 w. Eng News—May 16, 1907. No. 84384.

Providence.

New York, New Haven & Hartford Improvement at Providence. An illustrated description of the construction of a tunnel under the hill upon which Providence, R. I., is situated, and a bridge across the Seekonk river. 2000 w. Ry Age—May 3, 1907. No. 84099.

PERMANENT WAY AND BUILDINGS.

Construction.

Construction and Maintenance of Way. W. H. Hoyt. Discusses the important features of construction and maintenance of roadway and improvements in track construction. 2500 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84630 N.

Permanent Way; Its Construction and Maintenance. Arthur John Grinling. Discusses the details and construction of permanent way, the keeping of the line in repair and the renewal of defective and worn-out material. 4200 w. Inst of Civ Engrs, No. 555—No. 84458 N.

Curves.

Setting Out Curves. Thomas G. Bocking. Gives a simple rule and a table of tangential angles calculated upon it. 800 w. Engr, Lond—May 17, 1907. No. 84583 A.

Grades.

Value of Grade Reductions. William G. Raymond. Gives a statement of the problem and three methods of determining the result. 1000 w. R R Gaz—May 3, 1907. No. 84077.

Gravity Yard.

The Rutherford Gravity Yard of the Philadelphia & Reading Ry. Illustrated description of the new terminal yard, about five miles east of Harrisburg, Pa. 1500 w. Eng Rec—May 4, 1907. No. 84222.

Interlocking.

Electric Locking. W. H. Arkenburgh. An illustrated description of the electric locking system and its operation. 4000 w. R R Gaz—May 3, 1907. No. 84076.

Rails.

Breakages of Steel Rails. Robert Job. An illustrated article discussing some of the defects in steel rails, and the manner in which they may be discovered by inspection, and prevented in the course of manufacture. 3000 w. Cassier's Mag—May, 1907. No. 84053 B.

The Peril of the "Broken Rail"—Its Cause and Cure. Reports results of an investigation recently made by the editor, giving a statement of past and present conditions of rail making, and concluding that it is necessary to abandon the Bessemer process and adopt the Open Hearth process and return to slower methods of manufacture. Ills. 2500 w. Sci Am—May 18, 1907. No. 84391.

Defective Rails. A collection of unsigned letters concerning the quality of the rails furnished by the steel companies, with editorial comment. Ills. 6500 w. R R Gaz—May 17, 1907. No. 84382.

Note on the Wear of Rails. Léon de Lubimoff. Aims to determine what relation exists between the hardness of rail steel and its mechanical properties. Ills. 3800 w. Bul Int Ry Cong—April, 1907. No. 84522 E.

Proposed Use of Vanadium in Rail Metal. B. de Alzuaray, in the New York *Commercial.* Discusses the causes of rail breakage and the proposed remedies, advocating the introduction into the manufacture of steel of a suitable portion of ferro-vanadium alloy. 700 w. Ry & Engng Rev—May 18, 1907. No. 84398.

Rail Fractures on Railways in New York State. Information from a bulletin of the New York State Railroad Commission showing the total number of rail breaks on the principal steam railways of the state during the winter months, January to March, of the last three years. 900 w. Eng News—May 2, 1907. No. 84045.

Sand Blast.

Railroad Sandcraft. J. M. Betton. On the application of the sand blast to railroad service. 3300 w. Compressed Air—April, 1907. No. 84534.

Shops.

Locomotive Shops at Trenton. An illustrated detailed description of the shops of the Pennsylvania Railroad. 1800 w. Ry Mas Mech—May, 1907. Serial. 1st part. No. 84268.

Signaling.

A New System of Block Signaling on the Pennsylvania R. R. Gives an abstract of a descriptive statement in regard to the new system now in experimental service. Also editorial. Ills. 7000 w. Eng News—May 9, 1907. No. 84292.

Course for Apprentices in Signal Engineering. Information relating to the terms of employment of the Union Switch & Signal Co., with editorial comment. 1200 w. Ry & Engng Rev—May 18, 1907. No. 84399.

Prussian State Railway Signals. W. H. Pockels. Illustrates and describes the signals used. 1000 w. R R Gaz—May 24, 1907. No. 84540.

Station.

Proposed New Union Station at Toronto. Illustrated description of a station for use of the Grand Trunk and the Canadian Pacific railways. 1800 w. R R Gaz—May 24, 1907. No. 84542.

Terminals.

Freight Terminal of the Central of New Jersey in the Bronx. Plans and description of the method employed to utilize every available square foot of the restricted ground secured in the vicinity of New York City. 1200 w. Ry Age—May 10, 1907. No. 84284.

The Delaware, Lackawanna and Western Railroad Terminal and Ferry-House at Hoboken, N. J. Kenneth M. Murchison. Illustrated detailed description of this new fireproof structure and its many interesting engineering features. 2000 w. Archts & Builds' Mag—May, 1907. No. 84355 C.

The Greenville Terminal of the Pennsylvania R. R. Plan and description of a terminal for freight service under construction just south of Jersey City. 2500 w. Eng Rec—May 11, 1907. No. 84320.

The Hudson Tunnels and Their Terminals. An illustrated article giving interesting information in regard to these tunnels and terminals. 1000 w. Archts & Builds' Mag—May, 1907. No. 84356 C.

Track Elevation.

The 16th St. Track Elevation of the Burlington at Chicago. Illustrates and describes the elevation of 2.4 miles of track in a very busy section, with construction of additional tracks and other new features. 1800 w. R R Gaz—May 10, 1907. No. 84286.

Tracks.

On the Economic Renewal and Maintenance of Railway Tracks for High Speed Traffic. L. Schlüssel. An account of the examination of a Vignoles track, with cramps, wedges, and shock-absorber or deadener blocks. Ills. 12700 w. Bul Int Ry Cong—April, 1907. No. 84520 E.

Yards.

Southern Railway Freight Yard at Atlanta, Ga. Plan and illustrated description of a one-hump yard arrangement. 1000 w. Ry Age—May 17, 1907. No. 84397.

TRAFFIC.

Car Handling.

Delay in Movement of Empty Cars at Terminals. W. E. Beecham. Discusses briefly methods of handling empty cars, especially referring to Chicago, with committee report and discussion of the rules of interchange. 8000 w. Pro W Ry Club—April 16, 1907. No. 84483 C.

The Movement of Freight Cars on American Railways. Abstracts of several recent papers on this subject, with editorial. 12000 w. Eng News—May 23, 1907. No. 84495.

Freight.

Comparative Summary of Freight Cars in Service on the Railroads of the United States. Table prepared from data contained in the annual reports of most railroads of the United States operating over 500 miles, with comments. 1800 w. R R Gaz—May 17, 1907. No. 84383.

Freight Handling at the Port of New York. From an article by William S. Root, in *Railroad Men*. An explanation of conditions at this port and the facilities provided for the expeditious handling of freight. 1700 w. R R Gaz—May 3, 1907. No. 84078.

MISCELLANY.

American Railways.

After Seven Years. H. Perry Robinson. The first of a series of articles giving some impressions of American railways after long residence abroad. 1600 w. Ry Age—May 10, 1907. Serial. 1st part. No. 84283.

India.

The Railways of British India. A brief review of the progress of Indian railways.

2200 w. Engr, Lond—April 26, 1907. No. 84259 A.

New England.

A New England Railroad Situation. An interesting editorial on the present aspects of leading New England lines and the recent changes. 1200 w. R R Gaz—May 3, 1907. No. 84072.

Regulation.

Objects and Effects of State Regulation. From an address by W. W. Finley. A discussion of recent state legislation, quoting opinions of Mr. Knapp, of the Interstate Commerce Commission, and matters bearing on this subject. 2300 w. R R Gaz—May 10, 1907. No. 84289.

Resistance.

A Discussion of Train Resistance. A short summary of a report made by a Committee of the Am. Ry. Engng. & Main. of Way Assn., indicating the character of the information obtained and the deductions drawn. 4200 w. Eng Rec—May 25, 1907. No. 84563.

STREET AND ELECTRIC RAILWAYS

Accounting.

Accounting of Depreciation by Electric Railways. Robert N. Wallis. Discusses methods used and matters to be considered in electric railway accounting. 2200 w. Jour of Acc—May, 1907. No. 84552 C.

Brooklyn, N. Y.

The Rehabilitation of the Brooklyn Rapid Transit Company. The first of two articles outlining the reasons for the public hostility toward this company, and considering in detail the efforts being made to give real rapid transit under very hard conditions. Also editorial. Maps. 5500 w. R R Gaz—May 10, 1907. Serial. 1st part. No. 84287.

The Brighton Beach Improvement of the Brooklyn Heights Railroad. Illustrated description of extensive changes in progress on the line to Coney Island. 1800 w. St Ry Jour—May 11, 1907. No. 84282.

Buenos Aires.

The Street Railways of Buenos Aires, Argentina. Gives the most recent statistics in regard to immense traffic on these lines, the style of cars in use, the various types of construction and other data of interest. Ills. 3000 w. St Ry Jour—June 1, 1907. No. 84685.

Couplers.

Standard M. C. B. Couplers for Interurban Cars. Brief illustrated description of the type of coupler used by the Pacific Elec. Ry., Los Angeles, Cal., which is capable of intercoupling with all rolling stock of that or any other system. 700 w. Elec Ry Rev—May 18, 1907. No. 84402.

Dispatching.

Combined Telegraph and Telephone System Used by the Interurban Railway, Des Moines. Describes a composite system having features of interest for interurban lines, and greatly diminishes the likelihood of a total interruption. 2000 w. St Ry Jour—May 18, 1907. No. 84373.

Fire Protection.

The System of Fire Protection at the Plank Road Shops of the Public Service Corporation of New Jersey. Martin Schreiber. Describes briefly some features of construction and the practice of the company in handling and storing material; and gives an illustrated description of the system of fire protection installed. 5000 w. St Ry Jour—June 1, 1907. No. 84684.

Freight.

Freight Handling at Birmingham, Ala. Gives billing and other forms used to facilitate the handling of shipment in the service between the city and suburban districts. 1000 w. Elec Ry Rev—May 18, 1907. No. 84403.

Interurban.

An Indian Territory Interurban System. Illustrated description of the line of the Choctaw Railway & Light Co., extending from South McAlester to Hartshorne. 1500 w. St Ry Jour—May 25, 1907. No. 84569.

Construction of the Lafayette & Logansport Railway. R. M. Feustel. Illustrated description of an interurban line in Indiana for high-speed service. 2000 w. Elec Ry Rev—May 4, 1907. No. 84205.

Operating Features of the Boston & Worcester Street Railway. An illustrated article fully describing the operative features and giving a schedule of the cost of power generation and operation. 10000 w. St Ry Jour—May 4, 1907. No. 84228.

The Ft. Dodge, Des Moines and Southern Railway. Illustrated description of this line, partly on private right of way, and partly on electrified old lines. 1700 w. Elec Ry Rev—May 25, 1907. No. 84599.

Layouts.

A Graphic Method of Determining Tie-Rod Spacing in Track Layouts. Claude W. L. Filkins. Gives a chart with directions for use and an explanation of the underlying principles. 800 w. St Ry Jour—June 1, 1907. No. 84686.

Lausanne.

Lausanne Tramways (Les Tramways Lausannois). M. E. Barraud. Notes on recent extensions in the network of interurban electric railways radiating from Lausanne, Switzerland, giving details of construction, operation, traffic, etc. Ills. 2500 w. Bull Tech Suisse Rom—April 25, 1907. No. 84111 D.

London.

City and South London Railway. Map, plans and description of the Islington to Euston extension. 3300 w. Tram & Ry Wld—May 2, 1907. No. 84352 B.

Mono-Rail.

A New Mono-Railway. Illustration with brief description of the mono-railway designed by Louis Brennan, and report of trials. 1000 w. Engr, Lond—May 10, 1907. No. 84450 A.

N. Y. Subway.

The Air of the New York Subway Prior to 1906. George A. Soper. Record of facts concerning the quality of the air of the subway before any change was made in the ventilating arrangements, with explanation of the conditions. Ills. 15000 w. Tech Qr—March, 1907. No. 84473 E.

Rail Corrugation.

The Causes of Rail Corrugation. Describes tests made by H. B. Nichols, and the apparatus used, which seems to prove the trouble to be due to vibration, either in the rails or in the entire track structure. Ills. 1500 w. Tram & Ry Wld—May 2, 1907. No. 84354 B.

Rail Corrugations in Philadelphia. Points out differences in practice in the street railways of England and America, and describes the conditions in Philadelphia and gives H. B. Nichols' conclusion that rail corrugations are caused by vibrating rails. Ills. 2000 w. St Ry Jour—May 18, 1907. No. 84372.

Rails.

New Rails for the Chicago Street Railways. Gives specifications for rails of the grooved girder type. 1500 w. Eng News—May 23, 1907. No. 84497.

Single-Phase.

Single-Phase Electric Traction. Charles Frewen Jenkin. Shows the progress made in other systems, and describes some of the more important apparatus and appliances used for single-phase traction, discussing the problems which arise in their working. Also discussion. Plates. 25000 w. Inst of Civ Engrs, No. 3647. No. 84469 N.

Single-Phase Railways. F. E. Wynne. An illustrated article describing in detail the single-phase system and its operation. General discussion. 9000 w. Pro Engrs' Club of Phila—April, 1907. No. 84524 D.

The Peoria-Bloomington Single-Phase Line. A road built on a private right of way 80 ft. wide, in Illinois, is illustrated and described. 1200 w. St Ry Jour—May 4, 1907. No. 84231.

South America.

Tramway System of Montevideo. An illustrated description of the electrically operated lines at the capital of Uruguay. 2500 w. St Ry Jour—May 4, 1907. No. 84230.

Station.

The Power Station of the Little Rock Railway & Electric Company. Illustrated description of a station which departs, in many details, from the usual practice. The notable features are the provisions for light and ventilation, the vertical loop system of the main steam and main feeder headers, and the cylinder lubricating system. 1800 w. St Ry Jour—May 11, 1907. No. 84281.

Terminal System.

An Experimental Test of a Railway Terminal System. A report of the test which was carried out at Coney Island, of the system invented by Neils Poulsen for operating the Brooklyn Bridge terminal. 2800 w. Eng News—May 9, 1907. No. 84297.

Third-Rail.

Proposed 1200-Volt Third-Rail Line in California. Particulars in regard to the California Midland Railroad which is to be operated with 1200-volt direct current, distributed by an under-running third rail. 800 w. Elec Ry Rev—May 4, 1907. No. 84204.

Third Rail Design, Composition and Resistance. E. Goolding. Discusses the drawbacks of the Vignoles or tee rails, and the advisability of using harder rails. 1200 w. Tram & Ry Wld—May 2, 1907. No. 84353 B.

Traffic.

Passenger Traffic in Greater New York. Information concerning the enormous passenger traffic to be provided for in Greater New York, its rapid increase, and the necessity of constantly increasing the facilities. 3500 w. Eng Rec—May 11, 1907. No. 84322.

Trail Cars.

The Successful Operation of Trail Cars in Denver. An illustrated description of the successful method of operation of trailers during the rush hours of traffic. 3000 w. Elec Ry Rev—May 4, 1907. No. 84203.

Wires.

The Supporting of the Trolley Wires on Alternating Current Lines (Aanleg en Constructie van den Werkdraad voor Wisselstroombanen). C. Feldmann. Illustrated description of various methods. 2000 w. De Ingenieur—April 27, 1907. No. 84188 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
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Génie Civil. *w.* Paris.
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Iron and Steel Trades Journal *w.* London.
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Jour. of Accountancy. *m.* N. Y.
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Mines and Minerals. *m.* Scranton, U. S. A.
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Nautical Gazette. *w.* New York.
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Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
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Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
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Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
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Proceedings Engineers' Club. *qr.* Philadelphia.
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Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
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Scientific American. *w.* New York.
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Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
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AUTHORS AND PAPERS FOR AUGUST, 1907

J. G. G. KERRY *(The Canadian Railway Commission)*—1886, graduated in Honor Course, civil engineering, McGill University, Montreal; 1886-1888, employed on railway location and railway construction by C. P. R.; 1888-1889, on the engineering staff of the Montreal Harbor Board; 1889-1890, location surveys of the Edmonston Railway; 1890-1893, employed on railway construction in South Carolina and West Virginia; 1893-1907, on teaching staff of McGill University and in department of surveying and railway engineering; 1893-1907, on surveys and construction for the East Liverpool Bridge Co., Ohio; 1899-1907, in private practice as a consulting engineer, giving attention particularly to steam-railway location and construction, and working generally under the orders of Mr. F. H. McGuigan, fourth vice president, G. T. R.; 1907, partner in the firm of Messrs. Smith, Kerry and Chace, consulting engineers, Toronto, Canada.

ALFRED GRADENWITZ *(A Museum of Traffic and Engineering)*—Born at Breslau, 1875; educated at the König-Wilhelms Gymnasium at Breslau, at the Charlottenburg Technical High School, and at the universities of Breslau, of Freiberg i. B., and of Geneva; Doctor of Philosophy of the University of Breslau, in physics and electricity. Has devoted especial attention to applied science from the standpoint of the physicist, and is a contributor to the scientific and technical press of Europe and America, being familiar with a number of modern languages; an expert in technical physics, at present living in Berlin.

FREDERICK KEFFER *(Copper-Smelting Practice in the Boundary District, British Columbia)*—A graduate in mining engineering of the Ohio State University and was connected with the staff of the mining department for some time after graduation. Following this, was connected with various mining companies in the United States and Mexico. In 1896, was appointed chief engineer and general manager of the British Columbia Copper Company, Greenwood, B. C., at the time of the formation of the company with which he has been connected ever since. In 1906, gave up the active managership of the company, which has developed into one of the largest producers of British Columbia, and now acts as consulting engineer with general oversight over the numerous working properties of the company. Is a member of the American Institute of Mining Engineers and was recently elected President of the Canadian Mining Institute.

GERARD B. WERNER *(The Operating Costs and Revenue of Urban Railways)*—Graduated from Columbia College in 1903 and from Columbia University, with the degree of electrical engineer, in 1905. Spent some time in electrical research work with Prof. M. I. Pupin, and later was engaged in the train-tests of the Interborough Rapid Transit Company under L. B. Stilwell and H. S. Putnam. Was connected with the Engineering Department of the Westinghouse Electric and Manufacturing Company for a year. At present electrical engineer with the Railway Electric Power Company, paying special attention to problems and calculations connected with electric traction and with the electrification of steam railroads. Is the author of several studies and papers on electrical subjects.

CHARLES U. CARPENTER *(Profit Making in Shop and Factory Management)*—A graduate of Princeton University with the degrees of mechanical and electrical engineer, has had a large experience in mining engineering and electrical manufacturing and in the supervision of large manufacturing plants; for some years he was factory supervisor and afterwards head of the labor department of the National Cash Register Company, Dayton, Ohio, U. S. A. Later took a similar position with the Herring-Hall Marvin Safe Company, rising rapidly to the presidency of the concern.

AUTHORS AND PAPERS FOR AUGUST, 1907.

WILLIAM D. ENNIS *(Efficiency in the Burning of Fuel Under the Steam Boiler)*—Apprenticed to the Rogers Locomotive Company; drafting office, Passaic Rolling Mill Company; engine-room, Consolidated Gas Company of New Jersey; engineer of construction, Walworth Construction and Supply Company; designing engineer, Tower and Wallace. From 1901, employed in various engineering capacities in industries personally controlled by Mr. John D. Rockefeller, including the Puget Sound Reduction Company, the Monte Cristo Railway Company, the Everett (Wash.) Pulp and Paper Company, and finally, the American Linseed Company, where he served successively as constructing engineer, chief engineer, and engineer-superintendent. Recently appointed to the chair of mechanical engineering in the Polytechnic Institute, Brooklyn. A specialist in power-plant operation; has devoted attention to a constantly increasing extent to the general subject of economical production. A frequent contributor to the technical literature of both subjects. His present series began in the June number of THE ENGINEERING MAGAZINE and will continue for three or four months to come, taking up the burning of small grades of anthracite and the use of powdered fuel.

H. COLE ESTEP *(The Position and Equipment of the Puget Sound Navy Yard)*—Born near Seattle, 1886. Is a graduate of the department of mechanical engineering at the University of Minnesota. Has had recent facilities for studying the Bremerton yard on the ground, and thus has been able to collect his material at first hand and to base his conclusions on actual observation.

JOS. H. HART, Ph. D. *(The Value of the Indicator in Refrigeration Work)*—Graduated from Yale University (A. B.) in 1898, and took his degree of Ph. D. from the same institution in 1900; was connected with the faculty of Yale for a time, and then entered the faculty of the University of Pennsylvania in the department of physics; he is a member of the American Physical Society, of the American Association of Refrigerating Engineers, and fellow of the A. A. A. S.; he has made a specialty of thermodynamics, and of the steam-engine and of refrigerating-machinery design.

GEORGE F. STRATTON *(The Pursuit of Inventing a Business)*—For thirty years connected with manufacturing corporations in various capacities, in the factory, the office, and on the road. For ten years past has been with the General Electric Co. at their Lynn works, where 10,000 hands are employed. His intimate acquaintance with engineers and officials has thus afforded him ample opportunities for observing the working of one of the greatest of American machine shops.

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THE CANADIAN RAILWAY COMMISSION.

By J. G. G. Kerry.

No problem presses more strongly for solution in the United States than the regulation and control of the railway corporations. Some few still hold to the doctrine of "laissez faire" and would leave the corporations entirely to their own devices; others see in government ownership the only remedy for existing evils; but the mass of intelligent public opinion rejects both of these solutions, fearing alike the influence of private greed in the first and of political interest in the second. The most satisfactory solution of the problem is apparently to be found in the establishment of a just and firm system of government control, removed as far as possible from the evils of political influence, short tenure of office, and the temptations of insufficient salary, while retaining to the management of public-service corporations the progressiveness and initiative of private enterprise. The Canadian system of railway regulation is one of the most notable examples of government control along these lines, and the following paper by one who has been in close touch with the operation of the system has a peculiar and timely interest.—The Editors.

THE history of the English race is the history of a long conflict for individual liberty. Our forefathers succeeded in winning for us civil and religious liberty in such measure of fullness that we sometimes fail to value our heritage, but they left the battle for financial independence for us to fight. Probably the power of the financial kings was never before so thoroughly consolidated and organized as it is today and never became a cause of unrest and vague fear to the mass of the people. That there is any sound reason for the existence of this vague fear, which is the true cause of the popular outcry against corporations, is a much debated question, and the corporations have most sincere advocates and most sincere opponents. It is, however, certain that the only law that the great majority of men accept without question is that they must earn their daily bread and they fear that the growth of the great financial and industrial corporations will make this task increasingly more difficult.

Some form of public control of industrial corporations is, therefore, generally desired, but it would be hard to get any large number of men to agree among themselves as to the extent to which that control should be exercised. The prominent wage earner and public-ownership advocate of today may be the corporation promotor of tomorrow, and his position on economic questions, if he be honest, cannot fail to change rapidly with his broadened outlook and his altered fortunes. But however the opinion of the individual may vary, it must be admitted that this question of effectively controlling corporations is perhaps the most important question of our national life today, and that any comprehensive effort to solve it is worthy of close observation and study.

The control of the Canadian railway corporations—and the law is being gradually amended to cover all transporation corporations—through the Board of Railway Commissioners is a notable example of such an effort. It is modelled on that solution of the problem which is advocated by those who hold that any undertaking is best managed by men whose personal advancement is directly dependent upon the success of the enterprise, and upon that alone. These thinkers admit that it is beyond question that the public official will, in many cases, be the equal or the superior of the employee of the private corporation in intelligence, integrity and industry; but they doubt whether he can fully and impartially devote his energies to the public service and still be certain of that recognition and reward which comes to all men of capacity who work steadily and faithfully for a well-managed private corporation. If the doubt is well founded and there are many examples to be quoted in support of it, then the abler and more forceful men will not find it to their interest to remain long in public service, and with their resignations the efficiency of that service will fall off.

This is the position of the Canadian publicist of today on transportation questions, and his legislation is shaped on the conviction that the products of the country can be most efficiently and economically handled by private corporations specially chartered for the purpose. But as it is necessary to grant very great privileges and powers to these corporations so that they may efficiently organize their systems, it is also held to be necessary to check the abuse of these powers, and to secure satisfactory service by restrictive legislation intelligently enforced. The machinery for enforcement has been provided by the creation of the Board of Railway Commissioners.

The method of appointment of this Board, its organization, jurisdiction, duties and powers are set forth in what is generally known as "The Railway Act of 1903" (Revised Statutes of Canada 1906, Chapter 37). This Act was itself simply a revision and a complete re-statement of the existing railway law of the Dominion and was drawn up under the direction of the late Hon. A. G. Blair, then Minister of the Department of Railways and Canals and a member of the Canadian Cabinet. At that time Mr. Blair had been for some seven years ex officio the chief executive officer of the Canadian Government lines, and responsible for the operation of about 1500 miles of railway. It was recognized that the revisions and proposed alterations included very material departures from established practice, and the clauses of the Act were therefore very fully discussed in the Committees of the Houses of Parliament. Also, advance copies of the Act were furnished to the railway companies who on their part organized joint committees representing each of the great departments of railway organization, and to each committee were submitted for criticism and report all the clauses bearing upon the work of that particular department. The objections taken by these committees were considered during the discussion of the legislation.

The result of this careful revision of the law was the creation of a Commission with wider powers over great interests and with greater territories under its jurisdiction than are entrusted to any other similiar commission, and these facts were recognized in the Hon. Mr. Blair's opening speech at the first meeting of the Board. Mr. Blair, who had resigned his post as a Minister of the Crown to become the first Chairman of the Board, in the course of his remarks dwelt on the great authority conferred upon the Board, expressing his desire that that authority should be used with moderation and conservatism, that the procedure of the Board should be as simple as possible and that no legal formalities should deter private interests from appearing before the Commission when in need of its assistance or protection. Broadly speaking, the policy then laid down has been steadily followed.

The Board may be considered as a Court created to try certain cases which arise out of the construction and operation of railways. In particular it has jurisdiction over matters concerning:—

(1) The construction details of new roads or of the improvements undertaken by existing lines.

(2) The crossings of highways, railways, power lines and drainage mains by railways.

(3) The rates that may properly be charged for the various services rendered to the public by the railways, the express companies and the telephone companies.

The Board is also charged with the collection of statistics of operation, with investigations of the operating of the roads, in particular of the accidents occurring on them, and with inspection of equipment. To some extent, also, it has become customary, when public outcry is made concerning any particular item of railway practice, for the Government to request the Board to make a report upon the matter, even if it does not lie within the ordinary field of the Board's activities. The Board, in fact, acts as a special adviser to the Government in matters involving the details of the art of railroading.

It was the expressed desire of Mr. Blair that counsel should not be needed when applications were being made to the Board, but under present procedure practically every case is presented by counsel. So numerous and so varied are the applications in which each large railway company is concerned that they have found it necessary to retain special staffs which practically devote their entire time to preparing for, and attending at, the hearings held by the Board.

The Board itself consists of three Commissioners, who are appointed by the Governor-in-Council for a period of ten years and are eligible for reappointment, it being provided, however, that a Commissioner shall cease to hold office upon reaching the age of seventy-five years.* The Board, through some one of its members, is well qualified to grasp quickly the wishes and needs of nearly every section of the Canadian community. It may be noted that no member of the Board had been prominent in the railroad world during his previous career. Having in view the great importance to Canada of efficient transportation, in the building up of a country which is as yet settled only along one edge and in which the larger communities are separated by magnificent distances, and also remembering the numbers of that great body of men whose advancement is directly dependent upon the success of the railway companies, it is a fair question whether the Commission should not be enlarged to include some representatives who by thought and training are especially qualified to understand the motives and desires of the railroad men. In support of this suggestion it may be said that there are few classes of men who are more completely absorbed in their professional work, and few whose plans and suggestions are more free from ulterior motives. It is not always recognized that, in the railroad world, the initiative in questions of detail comes largely from subordinate officers, who have no knowledge of the finances of the companies, and whose simple ambition is to make the roads as efficient as possible for the carrying on of their legitimate business. However, as most of the problems that come before the Board are thoroughly technical in nature, it was recognized that there would be need of an advisory staff of practical railroad men, and the Board now has under its direction a considerable number of engineers, inspectors, and investigators, chosen from the engineering, operating, and traffic departments of the railroads. It is the customary practice of the Board to refer every application immediately for report to the expert within whose department the matter lies.

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* The following is a very brief biographical note of the Commissioners now holding office.

Judge Killam, the Chief Commissioner, was born in the Maritime Provinces. After practising law for a considerable time at the bar of both the Province of Ontario and the Province of Manitoba, he was appointed a Judge of the High Court of Manitoba and was subsequently elevated to the Supreme Court of Canada by the present administration. When the Hon. Mr. Blair decided late in 1904 to resign from the Board so that he might be in a position to re-enter the political field, Judge Killam was selected as his successor.

The Hon. Mr. Bernier, the Deputy Chief Commissioner, is a native of the Province of Quebec, and is a lawyer by profession. He has been a prominent figure in political life and for some years was a member of the present administration, holding the portfolio of Inland Revenue, which he resigned early in 1904 to become a member of the Commission.

Dr. Mills was brought up on an Ontario farm but entered educational life, and after filling various posts with distinction became Principal of the Guelph Agricultural College, an institution maintained by the Province of Ontario, and of such efficiency that its Principal becomes to some considerable extent ex officio the head of the Ontario agricultural interests. Canada is mainly an agricultural country and there was a distinct demand from the farmers as a class that there should be someone on the Board who was in sympathy with them, and who was advised of their grievances.

The jurisdiction of the Board extends over all railways that are under the legislative authority of the Parliament of Canada and even the roads that are operating on Provincial charters are subject to the Board in matters pertaining to through traffic, crossings of railways and navigable waters, and criminals acts. The question as to the propriety of granting a Dominion charter to a company which proposes to operate entirely within the boundaries of a Province has not yet been settled by the gradual development of Canadian institutions. All lines of larger importance now endeavor to obtain a Dominion charter, while local electric-railway projects are content to operate on Provincial charters. The Board has all the powers, rights and privileges that are vested in a Superior Court, but an appeal upon matters of jurisdiction may be taken from the Board to the Supreme Court of Canada. All orders of the Board, on appeal, may be varied or rescinded by the Governor-in-Council, but the proportion of orders so appealed to the number of applications annually dealt with by the Board is extremely small.

Questions of procedure, notice, form of application, etc., are dealt with in the Act, or are prescribed by order of the Board, and great care is taken to see that all legal formalities are properly observed. It is the practice of the Board, when so requested, to hold its hearings at the place most concerned in the application, a practice which necessarily results in considerable delay in dealing with such cases, as it is not possible for the Board to give hearings in all sections of Canada as often as once in the course of a year. The demand for such hearings comes almost always from municipalities.

The part that the Board takes in the settlement of the various railway problems that confront the Dominion may be explained best by some brief comments upon its more important powers. In one very important particular the authority of the Board over construction is limited, for it cannot authorize the construction of any new lines except branches that are less than six miles in length. Railways in Canada can be built and operated only by specially chartered companies, and the promoters of every new railway project must secure the passage of a private bill through Parliament before they can legally take any steps towards the construction of the road. It is becoming more difficult from year to year to secure the passage of such bills, and it is not unknown for a bill to be so altered before its final passage as to fix such an unsatisfactory route for the lines, or to make the bonding powers of the company so limited that the project has been abandoned. The position taken by Parliament is that a railway is above all "a work for the general advantage of Canada," and that, therefore, it should not be planned solely for the private benefit of its promotors; and Parliament has seen fit to retain to itself the right to remodel any project into the form that it considers will be most satisfactory to the public. The Railway Act authorizes the Minister of Railways and Canals—not the Board of Railway Commissioners—to approve the route of a projected railroad whose charter has been granted, but in giving such approval the Minister holds himself to be governed by the exact wording of the special Act of Incorporation and by the discussion which took place and the representations which were made in the Committee meetings of the House. The clauses of the General Railway Act are made part of every special Act that is passed. The Board of Railway Commissioners, unless otherwise directed, is permitted to vary the route approved by the Minister to the extent of one mile, but this is the limit of its jurisdiction over the routes of new roads. The great battles between rival interests for the securing or protecting of territory must, therefore, be fought out in the House itself and not before the Board.

Perhaps the most noteworthy of the many powers vested in the Board is the right to authorize the expropriation of private lands for railway purposes without the owner's consent. Only those who have endeavored to build up a railway system in communities whose laws do not provide such powers can realize how vital they are to successful railway construction, and even those who have had lands taken from them which they would not willingly have sold at any price must appreciate the occasional necessity of sacrificing the wishes of the individual to the good of the community. The railway companies are required to file large-scale detail plans of their locations with the Board for approval after their route maps have been approved by the Minister, and this approval carries with it the right to expropriate by proper procedure the lands shewn by the plans to be required. The widths of the right of way that may be taken are clearly defined by the Act, and the Board will not authorize the expropriation of greater widths except on special application. There is, however, practically no limit to the area of which the Board can sanction the expropriation, if sufficient cause be shewn by the railway companies. The Board has established precedents for taking the lands of one railway company for the use of another, and of expropriating private lands necessary to the carrying out of railway construction, but not directly required for right of way. Cases do not frequently come up in which individuals endeavor to secure the alteration of a location by the Board in order that their properties shall not be affected, for it is realized that a private interest will not be permitted to hamper the progress of a semi-public undertaking; but there are a number of cases on record in which other railway companies or municipalities have actively opposed the approval of the location plans on the plea that a route less injurious to other important interests can be found. Railway extension is still desired in Canada to such an extent that opposition to the plans of a new company on the grounds of paralleling is given practically no consideration except during the passage of the special Act through Parliament. The awards, when properties are expropriated, are made by a specially selected Board of Arbitrators.

The Board may also fix the terms upon which one railway company will be authorized to use the lands, tracks and buildings of another company, but such terms are more commonly settled by private agreement between the railway managements without the intervention of the Board. The Board has in several cases fixed the switching charges at commercial centres entered by two or more railways, and has ordered the construction of interchange tracks to facilitate local movement.

The plans for the crossing of any line of transportation by a railway or of any railway by another line of transportation, be it canal, power line, railway or road, must be approved by the Board. Canadian practice in the matter of crossings has not yet taken the form of a hard and sharply-defined policy. Conditions throughout the country vary very greatly, and one application may be in connection with a crossing of two new lines in an unopened and unsettled district, and the next may deal with one that is in the heart of a crowded and highly developed city. The practice of the Board is to deal with each case on its merits, ordering alterations of alignment in some cases, separation of grades in others, interlocking plants in still others, and not infrequently no special protective appliances other than those required by statute. The plans for the alteration of existing crossings to provide for increasing traffic must also be approved by the Board, and the costs of such works may be apportioned by the Board upon the parties benefited, the orders in such cases usually being the expression of a compromise arrived at by the interested parties under pressure from the Board. In the case of new lines, the full cost of all crossing works is borne by the new company as a matter of recognized practice.

All the construction detail of the railways which materially affects the safety and convenience of the public is subject to the approval of the Board, but otherwise there is no interference with the companies' construction plans. The railways of the Dominion as a whole are built to a fairly high standard because it has been the policy of the Government to subsidize liberally all lines for the opening of which there has been active public demand, and all companies which accept such assistance are compelled to build to specifications drawn up by the Department of Railways and Canals. The time is near at hand when a railway will be regarded and treated throughout the Dominion in much the same way as any other commercial enterprise, but up to the present every great railway project has been undertaken primarily for the settling up and knitting together of the country, and the money necessary for construction purposes has been obtained on the security of a Government guarantee or a bonus grant. The various powers of the Board in construction matters are sufficiently extensive to justify the statement that within broad limits the actual cost of construction might be determined by the orders of the Board.

Of even greater importance to the railway world are the powers given to the Board for the settling of passenger and freight rates. These powers and the general policy of the Government with regard to rates cannot be summarized better than by direct quotation from the sections of the Act itself which deal with the regulation of freight rates, the clauses dealing with passenger traffic being very similar to those quoted.

> "321. The tariffs of tolls for freight traffic shall be subject to and governed by that classification which the Board may prescribe or authorize, and the Board shall endeavor to have such classification uniform throughout Canada, as far as may be, having due regard to all proper interests.
>
> "2. The Board may make any special regulations, terms and conditions in connection with such classification, and as to the carriage of any particular commodity, or commodities mentioned therein, as to it may seem expedient.
>
> "3. The company may, from time to time, with the approval of the Board, and shall, when so directed by the Board, place any goods specified by the Board in any stated class, or remove them from any one class to any other higher or lower class; provided that no goods shall be removed from a lower to a higher class until such notice as the Board determines has been given in the *Canada Gazette*.
>
> "4. Any freight classification in use in the United States may, subject to any order or direction of the Board, be used by the company with respect to traffic to and from the United States.
>
> "322. All tariff by-laws and tariffs of tolls shall be in such form, size and style, and give such information, particulars and details, as the Board may, by regulation, or in any case, prescribe.
>
> "323. The Board may disallow any tariff or any portion thereof which it considers to be unjust or unreasonable, or contrary to any of the provisions of this Act, and may require the company, within a prescribed time, to substitute a tariff satisfactory to the Board in lieu thereof, or may prescribe other tolls in lieu of the tolls so disallowed.
>
> "2. The Board may designate the date at which any tariff shall come into force.
>
> "3. Any tariff in force, except standard tariffs hereinbefore mentioned, may, subject to disallowance or change by the Board, be amended or supplemented by the company by tariffs in accordance with the provision of this Act.
>
> "4. When any tariff has been amended or supplemented from time to time, the Board may order that a consolidation and reissue of such tariff be made by the company.
>
> "325. The tariffs of tolls which the company shall be authorized to

issue under this Act for the carriage of goods between points on the railway shall be divided into three classes, namely,—

(a) The standard freight tariff;
(b) Special freight tariffs; and
(c) Competitive tariffs.

"326. The standard freight tariff, or tariffs, where the company is allowed by the Board more than one standard freight tariff, shall specify the maximum mileage tolls to be charged for each class of the freight classification for all distances covered by the company's railway.

"2. Such distances may be expressed in blocks or groups, and such blocks or groups may include relatively greater distances for longer than for shorter hauls.

"3. The special freight tariffs shall specify the toll or tolls, lower than in the standard freight tariff, to be charged by the company for any particular commodity, or commodities mentioned therein, as to it may classes of the freight classification, or to or from a certain point or points on the railway; and greater tolls shall not be charged therein for a shorter than for a longer distance over the same line in the same direction, if such shorter distance is included in the longer.

"4. The competitive tariffs shall specify the toll or tolls, lower than in the standard freight tariff, to be charged by the company for any class or classes of the freight classification, or for any commodity or commodities, to or from any specified point or points which the Board may deem to have declared to be competitive points not subject to the long or short haul clause under the provisions of this Act.

"327. Every standard freight tariff shall be filed with the Board, and shall be subject to the approval of the Board.

"2. Upon any such tariff being filed and approved by the Board the company shall publish the same, with a notice of such approval in such form as the Board directs in at least two consecutive weekly issues of the *Canada Gazette*.

"3. When the provisions of this section have been complied with, the tolls as specified in the standard freight tariff or tariffs, as the case may be, shall, except in the cases of special freight and competitive tariffs, be the only tolls which the company is authorized to charge for the carriage of goods.

"4. Until the provisions of this section have been complied with, no toll shall be charged by the company.

"328. Special freight tariffs shall be filed by the company with the Board, and every such tariff shall specify the date of the issue thereof and the date on which it is intended to take effect.

"2. When any such special freight tariff reduces any toll previously authorized to be charged under this Act the company shall file such tariff with the Board, and shall, for three days previous to the date on which such tariff is intended to take effect, deposit and keep on file in a convenient place, open for the inspection of the public during office hours, a copy of such tariff, at every station or office of the company where freight is received, or to which freight is to be carried

> thereunder, and also to post up in a prominent place, at each such office or station, a notice in large type directing public attention to the place in such office or station where such tariff is to be kept on file: Provided that the Board may by regulation or otherwise determine and prescribe any other or additional method of publication of such tariff during the period aforesaid.
>
> "3. When any such special freight tariff advances any toll previously authorized to be charged under this Act, the company shall in like manner file and publish such tariff ten days previously to the date on which said tariff is intended to take effect.
>
> "4. Upon any such special freight tariff being so filed, the company shall, until such tariff is superseded, or is disallowed by the Board, charge the toll or tolls as specified therein; and such special freight tariff shall supersede any preceding tariff or tariffs, or any portion or portions thereof, so far as it advances or reduces the tolls therein.
>
> "329. Competitive tariffs shall be filed by the company with the Board and every such tariff shall specify the date of the issue thereof, and the date on which it is intended to take effect: Provided that where it may be necessary to meet the exigencies of competition, or as the Board may deem expedient, the Board may make rules and regulations governing the filing and publication of such tariffs, and may provide that any such tariffs may be acted upon and put in operation immediately upon the issue thereof by the company, before they have been filed with the Board."

It will be noted that the powers of rate making as stated above are very wide and the shipping interests of the country have not been slow in making applications both for the readjustment of rates and for their actual reduction. The Canadian Manufacturers' Association, for example, has retained a trained railroad man as special adviser to its transportation committee, and has been well prepared to press its requests upon the consideration of the Board. Many orders have been issued specifically fixing the tariffs between various points for various commodities and the clauses of the Act which provide protection against discrimination in all its many forms have been freely invoked. As an extreme case it may be mentioned that the Board in the fall of 1905, at the time of the heavy grain movement and in the midst of a car famine, made an order, after application and hearing, specifying the proportion in which the available empty cars were to be distributed to the various grain ports on Georgian Bay.

Briefly, the policy that the Government has laid down and has entrusted to the Board to carry out is that all railway charges shall be fully known to the shipping public, that no discrimination either in favor of a locality or of individuals shall be permitted, that the charges themselves shall not be unreasonably high, and that the machinery provided shall be such that the tariffs can be rapidly adjusted to the varying conditions of trade. No effort, however, is to be made to discriminate legally against a locality that is favored by nature for the benefit of one that is not so well situated, and the great waterways of Canada which in extent and possibilities are perhaps unequalled elsewhere on the face of the earth are recognized as a great factor in the determination of the cost of long-distance transportation.

It will be recognized from this statement of the more important duties with which the Board is charged, and the list is by no means exhaustive, that their successful discharge calls for moderation, good temper, plenty of thought, hard work and heavy travelling. The Commissioners have in fact been given no easy task. They have been appointed to compel the railway corporations to be just and reasonable in their dealings with the public, but it cannot be said that the public is always just and reasonable in its demands upon the corporations, nor can it be expected that there will not be endeavors to force the Board by popular outcry into positions unfavorable to the corporations. The public gives but little consideration to the ultimate result of the granting of its desires, and it is in the main entirely ignorant of the very narrow margins of profit upon which the railways are operated and of the amount of extra expenditures that must be made in order that those desires shall be satisfied. It is also prone to think that the particular difficulty in the matter of accommodation or service or equipment of which it complains is such a little item that no good management would permit it to remain uncorrected. It forgets that there are hundreds of other difficulties each awaiting its turn for consideration and settlement, and that the men whose duty it is to decide upon such matters are ever being pressed on the one hand by demands for better and more frequent service, better rolling stock, better roadbed and better terminals, and that they are on the other hand prevented by law from making those increases in charges which would in any other business immediately follow an increase of operating expenses or the provision of more liberal accommodation. The policy of the Board being to hold its hearings at the place where the complaint originates, the evidence laid before it is necessarily affected by local prejudice and narrow outlook, and it can be no easy matter to weigh correctly the dispassionate testimony of the railway representatives against such interested evidence, and its more vehement endorsation by the local press.

In justice to the fairness of the Board, it may be said that no attempt has ever been made, to the writer's knowledge, to invest its decisions with a political character, and that the appeals taken against its orders have been few. It has, of course, had the advantage of working only in a period of great prosperity, during which the companies have been able to carry out orders which are sometimes considered to be too favorable to the public, without serious financial difficulty. There has been some comment by the members of the Board to the effect that the public is inclined to consider it as a commission for inquiry and not as a tribunal, and that there is a tendency to make very vague complaints with the expectation that the trained staff of the Board will be put to work to collect the necessary particulars, and to determine whether or not there is cause for complaint. In view of the breadth of the Commission's jurisdiction, and the immense territory over which it is called upon to work, it is evidently not reasonable that an appeal should be made to it except on the grounds of a very real grievance and accompanied by a very thoroughly prepared digest of the complaint.

In conclusion it may be said that the Board is to be regarded as an experiment in government, made by a rapidly growing country in an endeavor to provide that its railways shall be intelligently built with due regard to public safety and the general advantage, that they shall be properly equipped and efficiently operated, and that the charges for transportation shall be reasonable and free from all suspicion of manipulation in favor of private interests. The Railway Act, under which the Board exercises its authority, is a recent compilation and will be subjected to much amendment. The Board itself has been in active service for only a little over three years and its staff is not yet fully organized. It would be, therefore, entirely premature to express any opinion as to the ultimate success of this particular method of corporation control, and all that can be said at present is that the Board has so performed its duties that the Canadian people as a whole are entirely content that the experiment shall be continued.

A MUSEUM OF TRAFFIC AND ENGINEERING.

By Dr. Alfred Gradenwitz.

The value of permanent industrial exhibitions as a means of promoting technical education was ably argued by Mr. Alfred Sang in THE ENGINEERING MAGAZINE for October, 1906. In the following paper Dr. Gradenwitz describes one of the most important industrial museums in Germany, in which the exhibits are devoted principally to railroad engineering. —THE EDITORS.

THE Museum of Traffic and Engineering, *(Verkehrs- und Baumuseum)* recently inaugurated at Berlin is intended to contribute to a more general understanding of the present state of traffic and engineering, while facilitating investigations and improvements relative thereto. The exhibits accordingly comprise mainly modern plants, the historical part being confined to those subjects which are either of paramount importance, or indispensable for an understanding of present-day installations.

The museum is located in the old Hamburg Passenger Railway Station, the operation of which has been discontinued since the purchase of the Berlin-Hamburg Railway by the Prussian State. The station building, however, required thorough reconstruction, so far as its basement is concerned. The large courtyard between the building and the side wings was at the same time covered over with a three-aisle iron hall, extending along three axes beyond the side wings and thus ensuring a length of 71 metres and a width of 29 metres. This hall forms the main part of the exhibition, while a special railway and switching or shunting house, with its switching and signalling plants, was arranged outside.

The rooms of the museum, (4,800 square metres in total area) are provided with central heating, and with a complete electric-lighting plant, allowing the exhibits to be studied and models to be demonstrated in the evening as well as by daylight.

The reconstruction necessary for adapting the ancient railway station to its present purpose was designed and carried out by Regierungsrat Schwartz, (to whose courtesy the writer is indebted for the particulars given in this article) and by Regierungsbaumeister Dörgé.

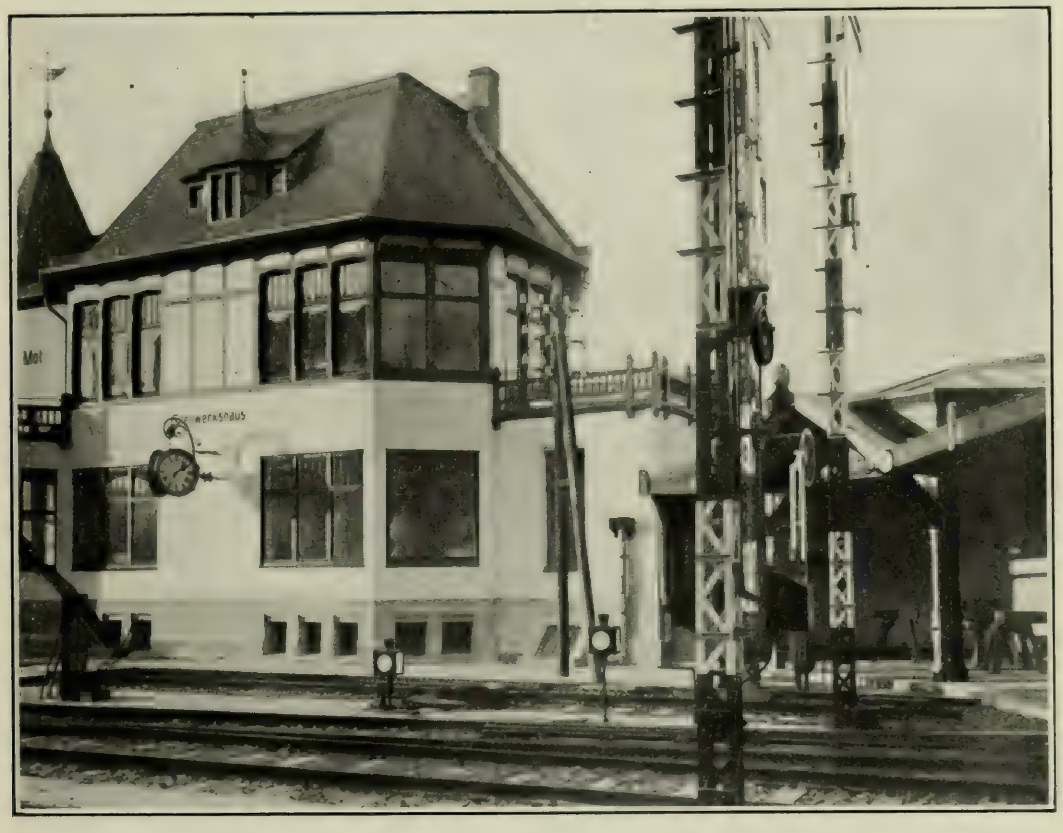
THE EXTERIOR OF THE MUSEUM.

The museum comprises three main departments, devoted to railway, naval, and civil engineering respectively. The exhibits belonging to related groups have been arranged in juxtaposition wherever possible. Explanatory notes are added to many exhibits, while in many cases a cross-section is given to illustrate the internal arrangement. Beside natural-size models there will be found many models on a reduced scale, especially of locomotives and signalling plants, which are operated either by hand, compressed air, or electricity. Whenever visitors are allowed to work the models themselves, the fact is mentioned by a special note. Models of plants of exceptional interest are to be demonstrated and explained from time to time by officials of the museum. Aside from rich stores of diagrams, photographs, and statistical tables, the institution comprises a reading room, in which outside of the trade papers of the day will be found a full library of rare and old books, thus allowing any part of railway and civil engineering to be most thoroughly investigated.

By far the greater part of the show rooms is occupied by the Railway Section, the exhibits of which are so comprehensive and numerous as to require a sub-division into several self-contained departments.

NAVAL ENGINEERING EXHIBIT.

Department A illustrates the evolution of railway tracks in all their parts, comprising rails, supports, sleepers, switches, and crossings, from the origin of railways till the present day. Samples of materials required for the upkeep and maintenance of the permanent way will likewise be found there. Sections of worn-out sleepers and rails, removed from the tracks of very busy railway lines, will prove specially instructive for the study of the wear of these parts of the track, while the influence of the shocks exerted on the roadbed and material by running locomotives and wagons will be demonstrated by sample cases prepared in a special testing plant. The large variety obtaining in the road material is illustrated by a collection of various kind of broken stone used as rail ballast. Another collection comprises such tools as are used in laying and replacing rails and sleepers.



EXHIBITS OF SIGNALLING AND SAFETY DEVICES, RAILWAY TELEGRAPH AND TELEPHONE PLANTS.

Three plates hung upon the walls give a comprehensive view of the successive increases made since 1842 on the rails and sleepers of Prussian State railways in order to allow for the increasing requirements of heavier carriages and augmenting speeds.

A relief model illustrates any details such as safety barriers, fire-protection strips, draining ditches, etc., of road crossings. A few special models of road barriers on a larger scale will likewise be found on exhibition, while engineering diagrams and models of snow ploughs are other features of this department.

Department B comprises any civil-engineering work required in connection with the construction of railways. In the center of the vestibule will be found a relief model of the railway station of Altona, the tracks of which are a model plant illustrating the principle of avoiding wherever possible any crossings of the rails at grade, in order to increase the safety and smoothness of operation. The construction of locomotive sheds, water towers, goods sheds, transfer stations and passenger stations, is demonstrated by a collection of models, diagrams, and pictures, the continual evolution in this branch of railway engineering being illustrated by a few models of early construction. Engineering diagrams covering all kinds of railway office buildings and sanitary installations for the welfare of railway employees will be likewise found here.

DEPARTMENT C. RAILWAY SIGNAL SYSTEMS.

Another interesting exhibit is the model of the first large iron bridge ever constructed in Germany, viz, the Vistula Bridge near Dirschau, completed in 1857. A number of diagrams and collections relating to railway bridges of ancient and modern construction will be found very instructive for the student of bridge building. The construction of tunnels is likewise explained by sketches and diagrams, while a model of the ventilating plant of the Kaiser Wilhelm tunnel near Cochem is likely to arouse special interest.

DEPARTMENT C. SWITCHING INSTALLATION.

Department C relates to railway-signalling and telegraph and telephone plants, comprising all such devices as have been designed for insuring the safety of operation on railways.

An electrically operated shunting plant, constructed by Messrs. Siemens & Halske, and two mechanical shunting plants, are exhibited ready for operation in connection with a complete track, switches, and signals arranged outside the building. This plant was constructed on the lines of the highly praised "German railroad" exhibited at the St. Louis Fair, all its apparatus being typical of the latest type. A compressed-air switching plant with electrical control, as well as a number of block systems and shunting plants, either in originals or models, are exhibited in the main hall on a platform. On the gable wall there are installed, ready for operation, block systems, telegraph and telephone plants, and other arrangements used in the manager's room of railway stations, these apparatus being conveniently connected with the remaining parts of the plant, so as to afford a faithful illustration of their mutual relations.

Block systems for both single-track and double-track railways, and electrical alarms and track telephones exhibited in a condition ready for operation, fitly illustrate the signalling service of railway lines, the advance made in this connection being inferred from a comparison of early and recent devices.

The most extensive department is Department D, comprising railway locomotives and wagons, and which takes up nearly the whole of the main hall, in additon to two adjoining rooms. A comprehensive collection of models of locomotives and wagons to a scale of one-fifth natural size enables the construction of the usual types of rolling stock to be studied, both in historical development and present details. The greater part of the locomotive models were made by apprentices of the workshops of Prussian State railways. while several other models are gifts from locomotive works. These models are the more instructive, as they can be operated by compressed air. This collection comprises models of four and five axle bogey locomotives, compound and superheated-steam locomotives, toothed-wheel locomotives, the cab in an express locomotive, the smoke-box in a superheated steam locomotive, etc. The collection of models of wagons comprises both passenger and goods wagons, some types of the latter being especially interesting. A collection of models of railway compartments, both old and up-to-date, fitly illustrates the gradual advance made in the heating, lighting, and sleeping outfits of railway cars.

Among other interesting features of this section of the exhibition are two brake batteries, each of which consists of twenty brakes of the Carpenter and Westinghouse types respectively. The operation of the brakes in a train of twenty carriages is thus illustrated in a most instructive manner.

Among exhibits of historical interest should be mentioned an

DEPARTMENT C. SIGNAL SYSTEMS, RAILWAY TELEGRAPHY AND TELEPHONY.

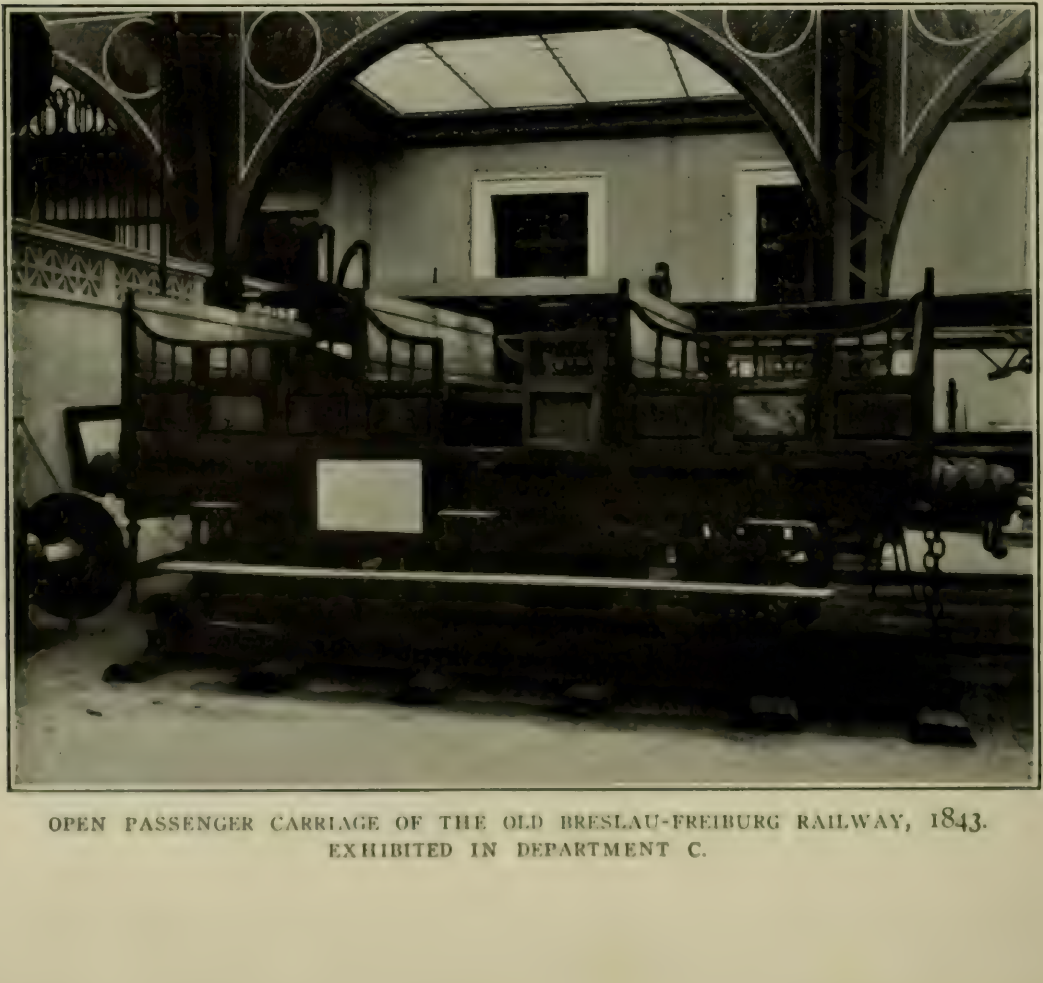
open passenger carriage of the ancient Breslau-Freiburg railway dating from the year 1843. These collections are supplemented by model diagrams.

Department E comprises high-tension electric plants for lighting, power-transmission, and railway operation.

Special interest attaches to the various parts of electric railways, including overhead lines, conductor shuntings, track insulators, track switch-outs, rail joints, controllers, driving motors, etc., which are mainly donations from the Allgemeine Elektricitätsgesellschaft and Siemens Schuckert Werke. This collection affords a practically comprehensive view of the development and present state of electric traction, at least in Germany. Only a few models of standard-gauge electric railway vehicles are however shown, of which the motor car used by the Siemens Company in connection with the famous Berlin-Zossen high-speed trials is most interesting. Another valuable exhibit is the first practical single-phase motor ever constructed for railway traction, which is designed on the Winter-Eichberg system. This motor was the first to demonstrate the possibility of operating trunk railways by high-tension alternate current from a single overhead wire. The model of a motor car of the Blankenese-Ohlsdorf Metropolitan and Suburban Railway (which is the first railway of this kind operated with single-phase current) will be installed shortly.

Department F is given up to the management of railway workshops and the mechanical equipment of railways.

While the Prussian Railway Department does not undertake to



OPEN PASSENGER CARRIAGE OF THE OLD BRESLAU-FREIBURG RAILWAY, 1843.
EXHIBITED IN DEPARTMENT C.

DEPARTMENT D. EXHIBITS OF ROLLING STOCK.

build any new vehicles, it runs extensive workshops for the up-keep and reconstruction of vehicles, its equipment comprising 15,368 locomotives, 28,723 passenger carriages and 320,198 luggage vans and goods wagons. Models of the main workshops of Opladen and Gleiwitz will be found to the left of the main hall. The operation of these workshops is illustrated by models of machine tools made to the scale of 1 to 5. Some of these machine tools are designed so that they can be operated. An interesting exhibit is a model of an attachment for quickly exchanging worn-out wheel sets in railway carriages. Other models comprise turn-tables and travelling platforms, as well as a Dowson gas plant, supplying the gas used in the lighting of railway cars.

Among other remarkable exhibits may be mentioned models of railway ferries, coal-wagon tilters, and an apparatus for exchanging the trucks of normal gauge to trucks of Russian gauge, and the mechanical ventilating plant for the Kaiser Wilhelm tunnel. Mechanical locomotive-coaling plants recently installed on German railway stations are likewise shown.

Railway management from a business point of view is covered by Department G, which in addition to all kinds of printed matter on railway traffic and management, comprises such devices as are used in

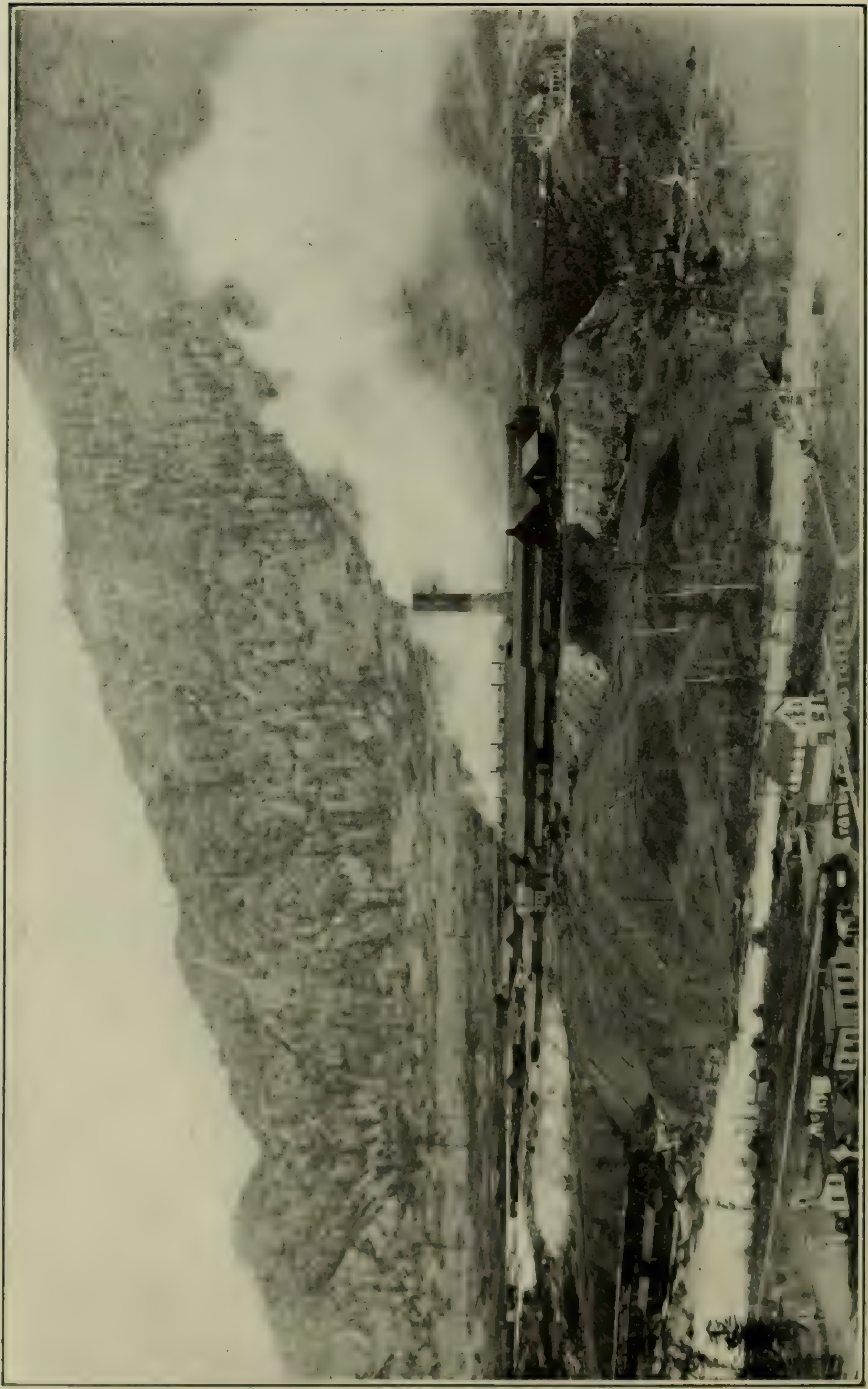
DEPARTMENT D. PARTS OF LOCOMOTIVES AND OTHER ROLLING STOCK.

the making up of trains, as well as signalling devices (connected with the shunting plant installed in Department C), and fully equipped ticket and luggage offices in addition to a station room electrically connected to the shunting plant, and from which the controlling of the railway and shunting service by a single official is demonstrated.

Department H comprises extensive collections of all kinds of documents, time-tables and official records, relative to the establishment, construction, and management of railways, as well as to the welfare of railway employées.

The collections installed in the eastern side wing and the adjoining section of the main hall are devoted to naval engineering, including river, canal, and marine construction. The most recent achievements of civil engineering—such as weirs, reservoir embankments, sluices, viaducts, as well as the improvement work on natural and artificial waterways, river and harbour plants, and the construction of dykes—are illustrated by a number of models, plans and pictures. The operation of light-houses is likewise covered by a collection of apparatus designed to be shown in full working order. Models of Heligoland, of the Königsberg sea channel, of the Swinemünde-Stettin waterway, with a self-contained, electrically operated lighting plant, as well as models of steamships, steam dredges, etc., should be especially mentioned. These collections are supplemented by a number of treatises and trade papers located in the special reading room.

The department devoted to civil engineering comprises recent construction by the civil-engineering department of the Prussian State, as well as a number of models of recent State buildings, and an extensive collection showing building materials and construction methods.



THE GRANBY SMELTER, GRAND FORKS, BRITISH COLUMBIA.

COPPER-SMELTING PRACTICE IN THE BOUNDARY DISTRICT, BRITISH COLUMBIA.

By Frederic Keffer.

THE Granby Consolidated Mining, Smelting and Power Co. was the first concern in the District to undertake the building of a smelter plant. Construction on its plant at Grand Forks was started in the summer of 1899, and by August of 1900 the first of the 300-ton furnaces was blown in, followed in October by the second. In the spring of 1902 two more furnaces built during the winter were blown in, and in January of the same year the converter plant, then the only one in the Boundary, was put in successful operation. In the early winter of 1903 two more furnaces were blown in, and in October of 1905 still another pair were added, thus making eight in all, and giving the plant a capacity of some 3,000 tons per day. This great plant has treated up to the first of June of the current year some 3,380,000 tons.

The British Columbia Copper Co. Ltd., began work on its smelter plant at Greenwood in the fall of 1899, shortly after the Granby Company had begun its work. The first furnace was blown in in February, 1901, and in 1902 a second 300-ton furnace was added to the plant. In the summer of 1904 the converter plant was started, the matte having previously been blown up to blister copper by outside plants. In 1906 it was decided to reconstruct and enlarge the plant on the most modern lines, and during that year the old furnaces were torn down and replaced by the present plant of three huge furnaces, the capacity of each furnace being 650 to 750 tons per day, making the whole a smelter of from 1950 to 2250 tons daily capacity. The first of these furnaces was blown in in October, 1906, and the last in the spring of the present year. Up to the first of June the British Columbia Copper Co. had smelted 1,110,000 tons of ore.

The original plant of the Dominion Copper Co., at Boundary Falls, was built in 1900 by parties whose idea was to do pyritic smelting. Inasmuch as the Boundary ores are very low in sulphur, it is needless to say that the plant proved a failure. After divers vicissitudes the plant finally passed into the hands of the Dominion Copper Co., which company rebuilt it to a great extent, adding to the two furnaces then installed, a third huge furnace, the largest in the District. This furnace was recently blown in, and gives the smelter a capacity of from 1200 to 1400 tons per day. The smelter had treated 528,000 tons of ore up to June 1st.

As in other extensive mining districts, the ores of the Boundary include many diverse types, but for convenience they may be generally classified as follows:

General Classification of Boundary Ores.

Ores.	Basic.	Magnetites:—	Fine grained massive as in the	Mother Lode. Sunset. Emma.
			Specular—As in the	Knob Hill. Old Ironsides.
		Pyrrhotites:—Usually with some magnetite as in the		Mountain Rose. Napoleon. Senator. Morrison.
		Garnetites:—As in the Oro Denoro mines.		
		Calcites:—As in the Mother Lode.		
		Pyrites:—As in the Mother Lode and many other mines.		
	Acid.	Highly silicious altered lime products occurring in most of the Boundary mines.		
		Quartz with ores of copper disseminated through talcose schists, as in the Lone Star.		
		Quartz with galena, zinc blende and pyrite as in the (These are narrow veins with high values in gold and silver.)		Providence. No. 7. Skylark, and several other mines.
		Quartz with much arsenical pyrites, as in the Athelstan.		
	Neutral.	Altered volcanic ash, tufa, etc., impregnated with copper minerals as in most of the mines in Phoenix, for example the		Knob Hill. Old Ironsides. Snowshoe. Rawhide. Gold Drop. Monarch and many other mines.
		Altered eruptive rocks occurring near limestone contacts, and generally associated with dykes of porphyry, as in the		Mother Lode. The "B. C." Jumbo.

It will be seen from the table that although the Boundary ores are generally spoken of as "self-fluxing" there is, nevertheless, a wide range in the composition of ores from different mines in the District. The neutral ores, however, constitute a decided majority of the whole, and by suitably combining the others, neutral mixtures may be had without addition of barren flux, which fact, in effect at least, bears out the Boundary's claims as to its self-fluxing ores. Partial analyses of the different classes of ores are given on the opposite page:—

PARTIAL ANALYSES OF TYPICAL BOUNDARY ORES.

		Silica, Per cent.	Iron, Per cent.	Lime, Per cent.	Sulphur, Per cent.
Basic Types.	Emma Mine	12.60	46.10	11.30	1.00
	Napoleon Mine	16.60	43.20	2.50	24.80
	Mountain Rose Mine...	11.80	38.60	9.80	24.70
	Oro Denoro Mine......	29.10	22.10	22.90	1.75
Acid Types.	Lone Star Mine........	49.80	8.82	2.30	7.58
	Providence Mine	88.60	2.50	2.60	1.80
	Ben Hur Mine.........	76.80	1.90	9.80	.00
	Athelstan Mine	40.00	14.80	1.10	....
Neutral Types.	Mother Lode Mine.....	32.26	16.41	20.27	2.92
	Snowshoe Mine	34.30	12.86	18.43	2.56

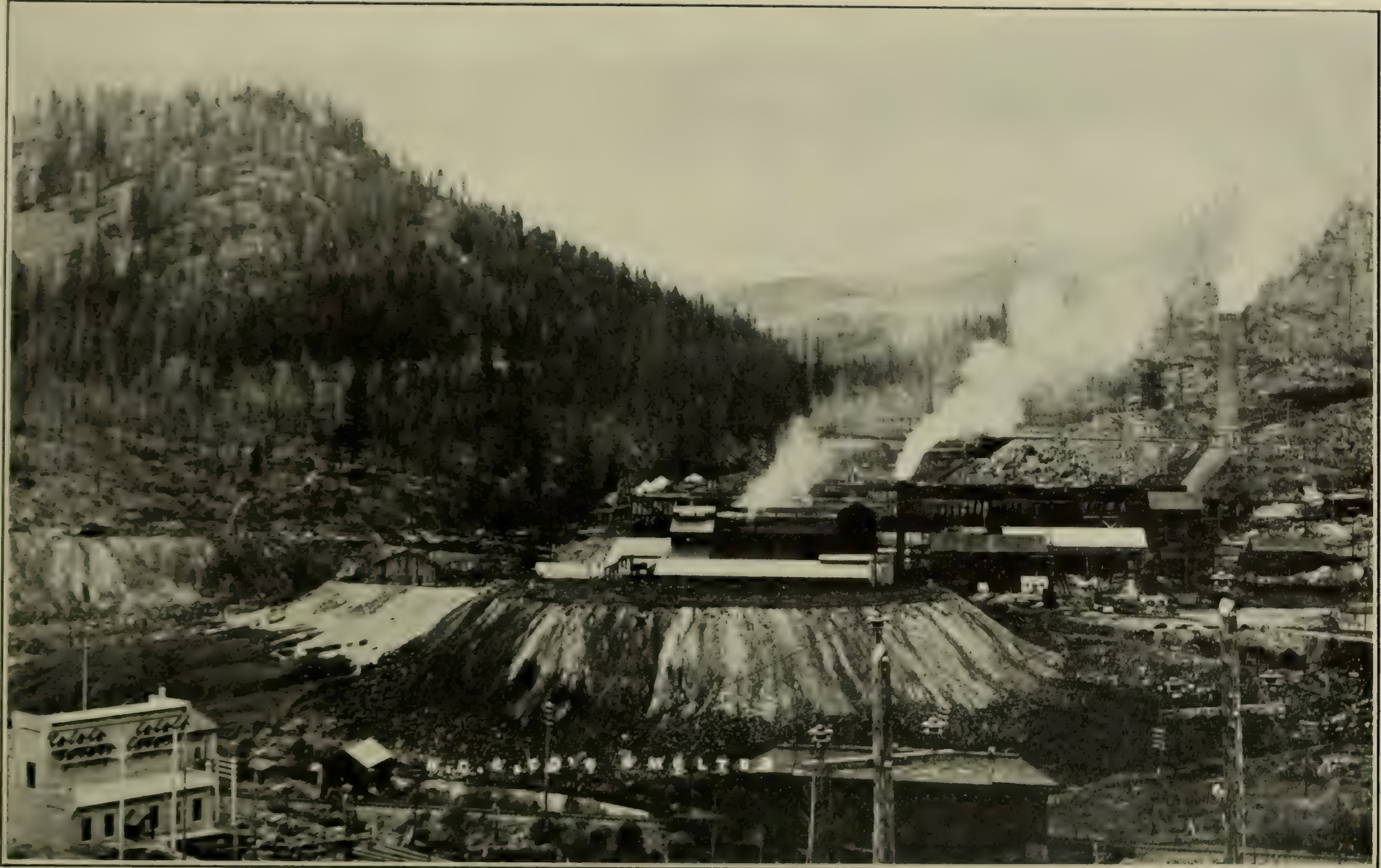
In these ores alumina will range from nothing to 15 per cent., the average being about 8 per cent. The following complete analysis of a sample of Mother Lode ore gives the percentages of the various constituents together with the manner in which they probably exist in the ore.

COMPLETE ANALYSIS OF MOTHER LODE ORE, FROM UPPER WORKINGS.

				Per cent.
Silica	SiO_2		Combined as Silicate	36.18
Alumina	Al_2O_3		" "	10.16
Lime	CaO	Total, 18.81 per cent.	" as Carbonate	9.34
			" as Silicate	9.47
Magnesia	MgO		" "	2.59
Potash	K_2O		" "	.25
Soda	Na_2O		" "	.32
Carbonic Oxide....	CO_2		" as Carbonate of Lime....	7.34
Copper	Cu		" as Chalcopyrite	1.94
Iron	Fe	Total, 14.36 per cent.	" "	1.71
			" as Pyrite, FeS_2	1.91
			" as Ferrous Oxide, FeO..	10.74
Sulphur	S	Total, 4.13 per cent.	" as Chalcopyrite	1.95
			" as Pyrite	2.12
Oxygen	O		" as Ferrous Oxide, FeO..	3.06
Water	H_2O	Total, 1.11 per cent.	" as Combined Water	.65
			" as Moisture	.46
			Total	100.25

Most of the Boundary ores contain lime as crystalline calcite, which mineral when heated in the furnaces tends to break up the whole mass speedily. Chiefly for this reason coarse crushing (from 4 to 6 inch size) suffices, a small saving in costs being thus effected.

Probably nowhere else in the world are copper ores containing sometimes as low as one per cent. of copper successfully smelted without any previous sorting or concentration. The Boundary ores run from 1 to 3 per cent. in copper, the average being not far from 1½ per cent. and from $1 to $3 per ton in gold and silver. It has been proved that ores containing 1.2 to 1.5 per cent. of copper will produce sufficient matte fall to collect the precious metals with but slight loss of these metals in the slag, and also sufficient to keep the furnaces in



THE BRITISH COLUMBIA COPPER COMPANY'S SMELTER, GREENWOOD.

good running condition. With 1 per cent. copper or less, the operation of the furnaces becomes exceedingly difficult as well as unprofitable. It is essential that there be enough sulphur in the ores to keep the matte within proper limits as to grade, a good average for matte being about 45 per cent. copper. Matte much richer than 50 per cent. copper occasions undue waste in slags, while matte running below 40 per cent. requires too much time for converting as well as too frequent renewals of converter linings. With the matte within bounds and with normal ores the slag losses in copper and precious metals can be kept within the limits of

Copper	.30 to .35	per cent.
Gold	.004 to .006	ounces
Silver	.04 to .06	"

per ton of slag. As the slag is about 85 to 90 per cent. of the charge, the loss per ton of ore is 85 to 90 per cent. of the above figures.

The following table shows in a general way the relations of copper, sulphur, and iron in varying grades of matte, this on the assumption that the matte is composed solely of these elements, which assumption is practically correct so far as this district is concerned.

COMPOSITION OF MATTES CONTAINING VARIOUS AMOUNTS OF COPPER.

Copper, Per cent.	Iron, Per cent.	Sulphur, Per cent.
40	31.8	28.2
42	29.5	28.5
44	28.1	27.9
46	26.4	27.6
48	25.2	26.8
50	23.9	26.1
52	21.4	26.6
54	20.4	25.6
56	19.2	24.8
58	17.2	24.8
60	15.3	24.7

From the above table it is seen that the sulphur required to form a 45 to 55 per cent. matte is about 25 per cent., or half as much sulphur as copper, so that an ore carrying 1.5 per cent. copper will require .75 per cent. sulphur. This, however, represents but a small part of the sulphur necessary in the charge, as by far the greater part is volatilized or burned to SO_2. In the Boundary a sulphur content of 5 to 6 per cent. is found requisite for good work. The ores mined by the Granby Company have as a rule sufficient sulphur for the matte, but the British Columbia Copper Co., and the Dominion Copper Co. supplement their sulphur with ores from their pyrrhotite mines, the Napoleon and Mountain Rose respectively.

The slags to work well must be neither so silicious as to be sticky, nor so basic with iron as to be too dense, as in neither case does the matte separate well from the slags. The following is the average composition of many thousand tons of slags made at the British Columbia Copper Co.'s smelter, which have been found satisfactory:

	Per cent.
Silica	39.77
Iron	20.62
Lime	22.11

The following is a complete analysis of an average of ten weeks' run of slag, taken at a period when the ores were a trifle more silicous.

	Per cent.
Silica	41.53
Iron (as silicate)	20.88
Magnesia	2.46
Lime	18.24
Alumina	9.10
Potash	.35
Soda	.46
Oxygen (with iron as FeO)	5.97
Copper (as matte mechanically mixed)	.37
Iron " " " "	.20
Sulphur " " " "	.17
Moisture	.15
Total	99.88

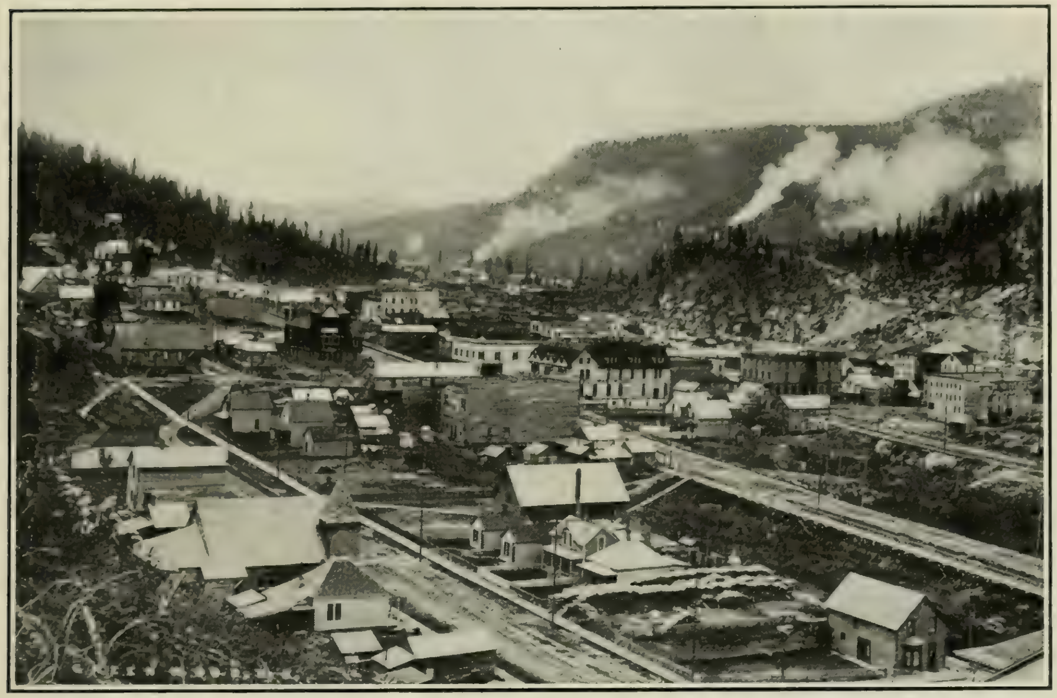
In the earlier history of the camp the tendency was toward more basic slags owing to the circumstance that in those days the ore mined was more basic than at present. The following analyses illustrate this point, being those of slags taken over considerable periods in the years named:

	Silica, Per cent.	Iron, Per cent.	Lime, Per cent.
1901	33.2	28.5	20.6
1902	40.5	22.2	20.2
1903	42.7	20.4	20.2
1904	43.3	22.0	16.3
1907	39.7	20.6	22.1

Latterly the ores have grown more basic, and the 1907 slags closely approximate those of 1902 in relative proportions of acid and base.

The amount of coke used is that which is just sufficient to properly fuse the charge, excess over this not only being wasteful, but also tending to reduce iron from the ore, at once robbing the mattes and building up troublesome "sows" in the hearths of the furnaces. It has been found possible to obviate the formation of sows entirely by regulating closely the amount of fuel used. The per cent. of coke varies between 12 and 13, the coke coming from the mines of the Crows Nest Pass.

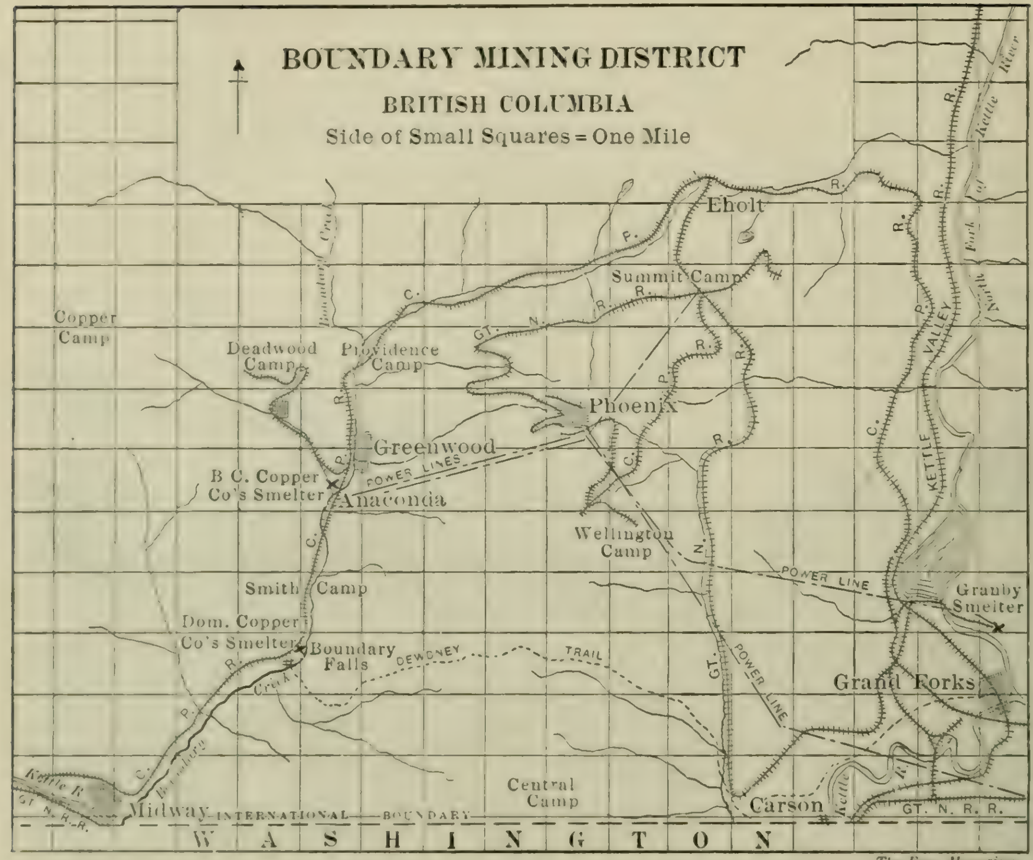
Foaming in the furnaces and settlers is occasionally troublesome, and appears to arise through the crystallization of magnetite (Fe_3O_4) from the fused mass of slag and matte. This mineral if heated beyond a certain point gives up an atom of oxygen, which, reacting on the matte, forms sulphurous acid gas, the bubbling of which interferes with the proper settling of the matte. The presence of sufficient sulphur in the charge and proper feeding usually prevent this trouble.



GENERAL VIEW OF GREENWOOD. THE BRITISH COLUMBIA COPPER COMPANY'S SMELTER IS IN THE DISTANCE.

The pressure of blast in the large furnace is 20 to 22 ounces per square inch, and in the smaller furnaces, 16 to 18 ounces. The amount of flue dust varies from 1 to 2 per cent. according to the season, the least forming with wet or frozen ores. The dust assays considerably higher than the ores from which it is derived, owing to the tendency of the softer chalcopyrite to break up. The dust is briquetted as fast as formed and returned to the furnaces. Fresh dust requires little or no lime as a binder, there being enough lime formed when the dust is in the furnace to bind the briquettes. Old dust usually requires some lime.

To describe in detail each of the smelters in the district would take more space than the limits of this paper will allow. The most recent of the plants, that of the British Columbia Copper Co. Ltd. at Greenwood, will therefore be taken as representatives of all the plants, embodying as it does the latest practice as developed in the Boundary. The elimination of labor was a cardinal point kept in mind when this



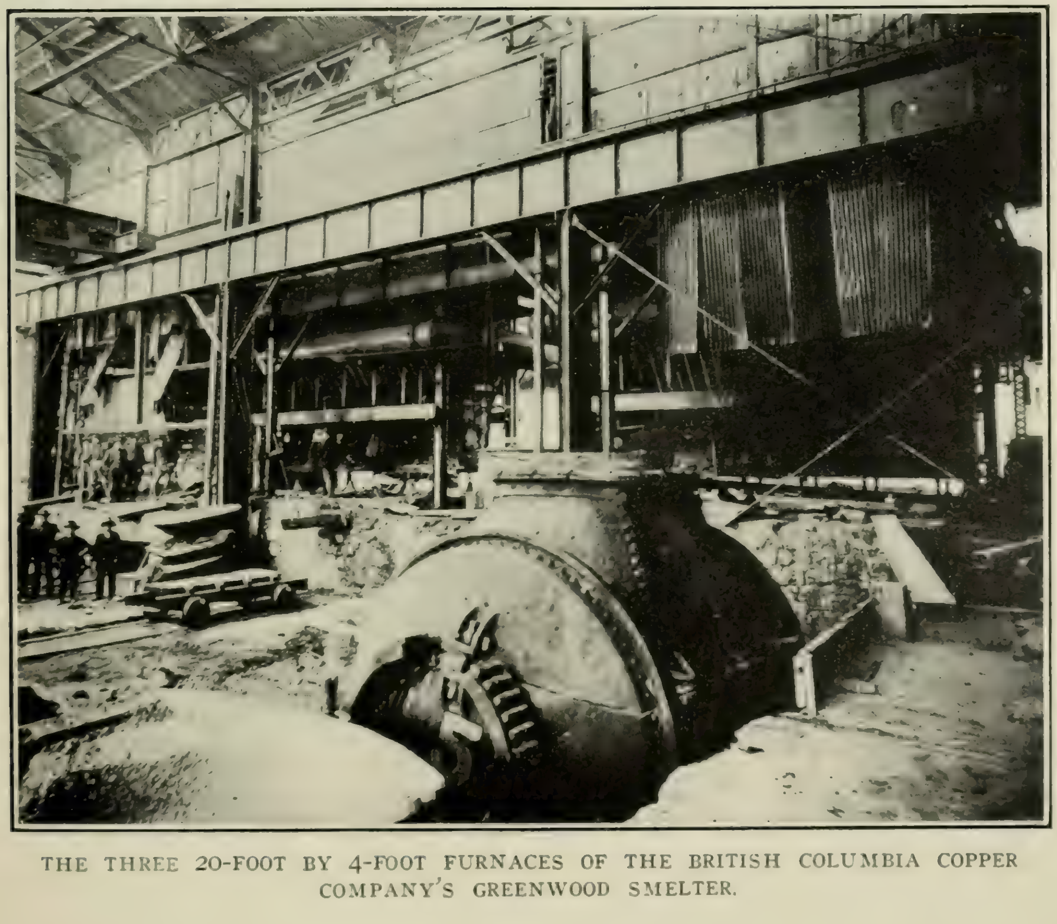
The Eng. Magazine

plant was designed, and this has been so successfully carried out that at present some 2000 tons are being smelted daily with a force aggregating about 135 men in the 24 hours.

Ores from the company's own mines are sampled by taking every tenth car, the uniformity of the ores permitting this to be done, thus saving time and expense. As all the ores are crushed at the mines, it is only needful to dump the unsampled ores directly in the bins whence it goes to the furnaces. Custom ores have, of course, to be sampled more carefully by passing the whole lots through the mill. Checks, based upon the extraction obtained and slag assays, are made at the end of each month, and it is found that the results obtained in this absolute manner agree very closely with the results obtained by sampling every tenth carload at the mill. In sampling, the ore passes through a series of four Johnson samplers, following Gates crushers and rolls, the final sample constituting about one-sixth of one per cent. of the original ore. The sample which, at this stage, is the size of wheat grains, is further quartered, bucked-down and passed through 80 or 100 mesh sieves in the usual manner.

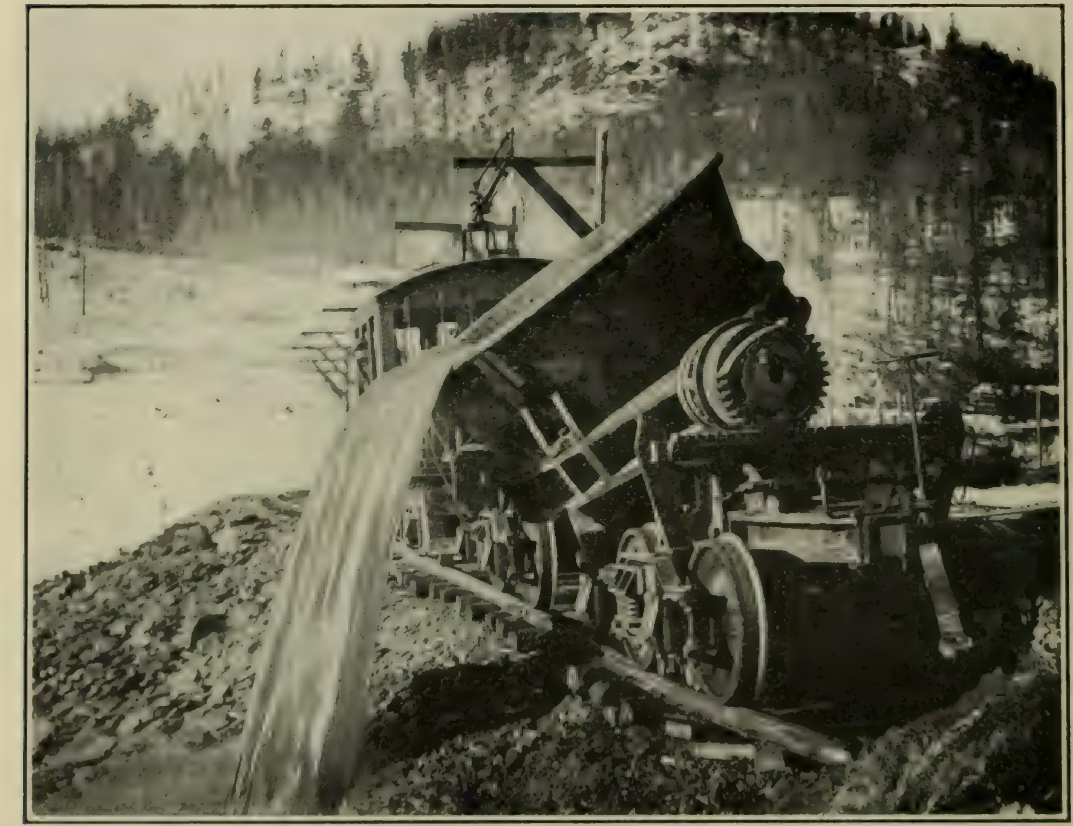
From the sample-mill bins the ore goes over a conveyor belt to railway cars which take it to the main smelter bins. The latter bins have a capacity of 12,000 tons of ore and 2,000 tons of coke. The ore next passes through chutes into the charge cars, which run six to a train, drawn by an electric locomotive. The loaded train passes over charge scales where the weight of each charge is brought to 5,000 pounds by additions from small piles of the same ore at the scales, or by removal of excess weight, as the case may be. The coke is similarly weighed into charge cars. The train then passes to the furnaces into any one of which the charge is dumped as desired. The furnaces are placed end to end, so that the charging tracks traverse the feed floor on each side of each furnace, thus allowing the charge to be fed in at any point. Baffle plates are hung inside the furnace to distribute the charge, and obviate the tendency of the fines to collect in a heap at the centre with the coarse ore rolling down the heap to the sides of the furnaces. This seemingly trifling point is of the utmost importance in the proper operation of the furnaces, as otherwise the matter is too high grade owing to the burning away of too much sulphur.

At the Granby works the charge cars are run directly into the furnace at the end, and the charge dropped through the bottoms of the cars. This plan distributes the ore and coke well, and produces good results. The system of side-dumping cars employed at Green-



THE THREE 20-FOOT BY 4-FOOT FURNACES OF THE BRITISH COLUMBIA COPPER COMPANY'S GREENWOOD SMELTER.

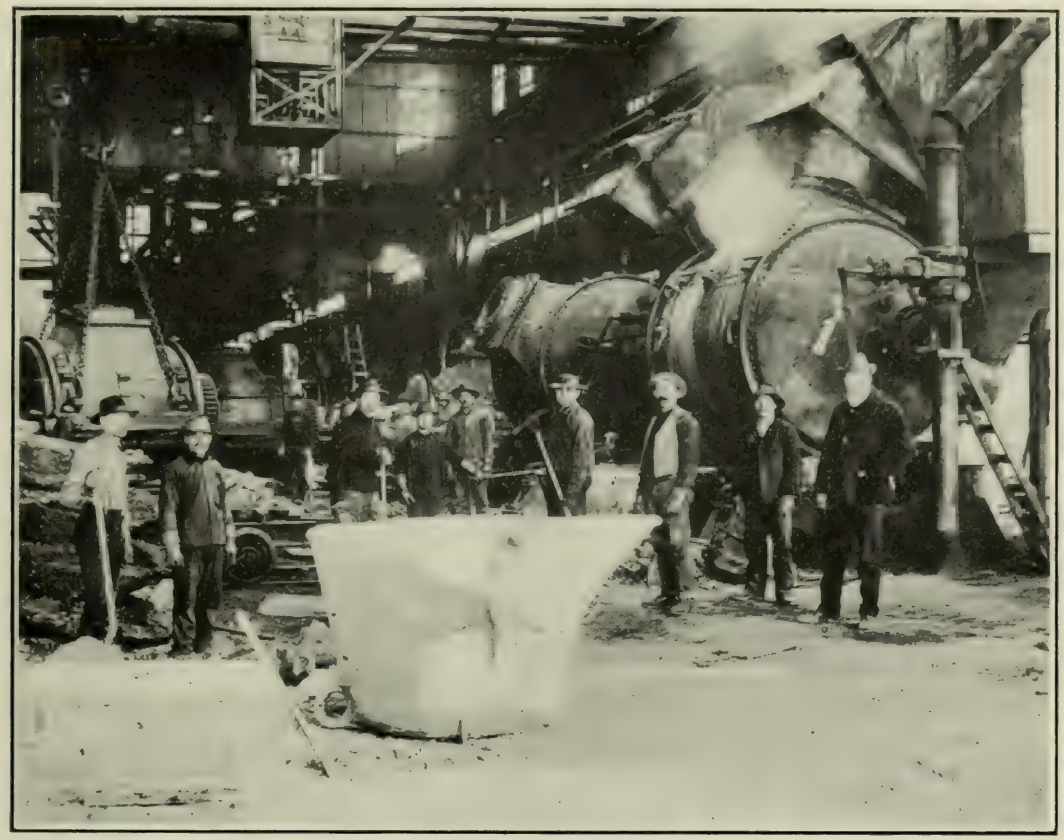
wood involves less switching of cars, and reduces track complications. The Greenwood furnaces are 48 by 240 inches at the tuyeres, and have a hearth area of 80 square feet. As the furnaces average some 650 to 750 tons each per day, the tons smelted per square foot of hearth area are 8.1 to 9.4 per day. There are 6 jackets and 24 tuyeres on each side of each furnace, the water jacketing extending all the way to the feed floor, thus reducing brick repair work to a minimum.



DUMPING MOLTEN SLAG, GREENWOOD SMELTER OF THE BRITISH COLUMBIA COPPER COMPANY.

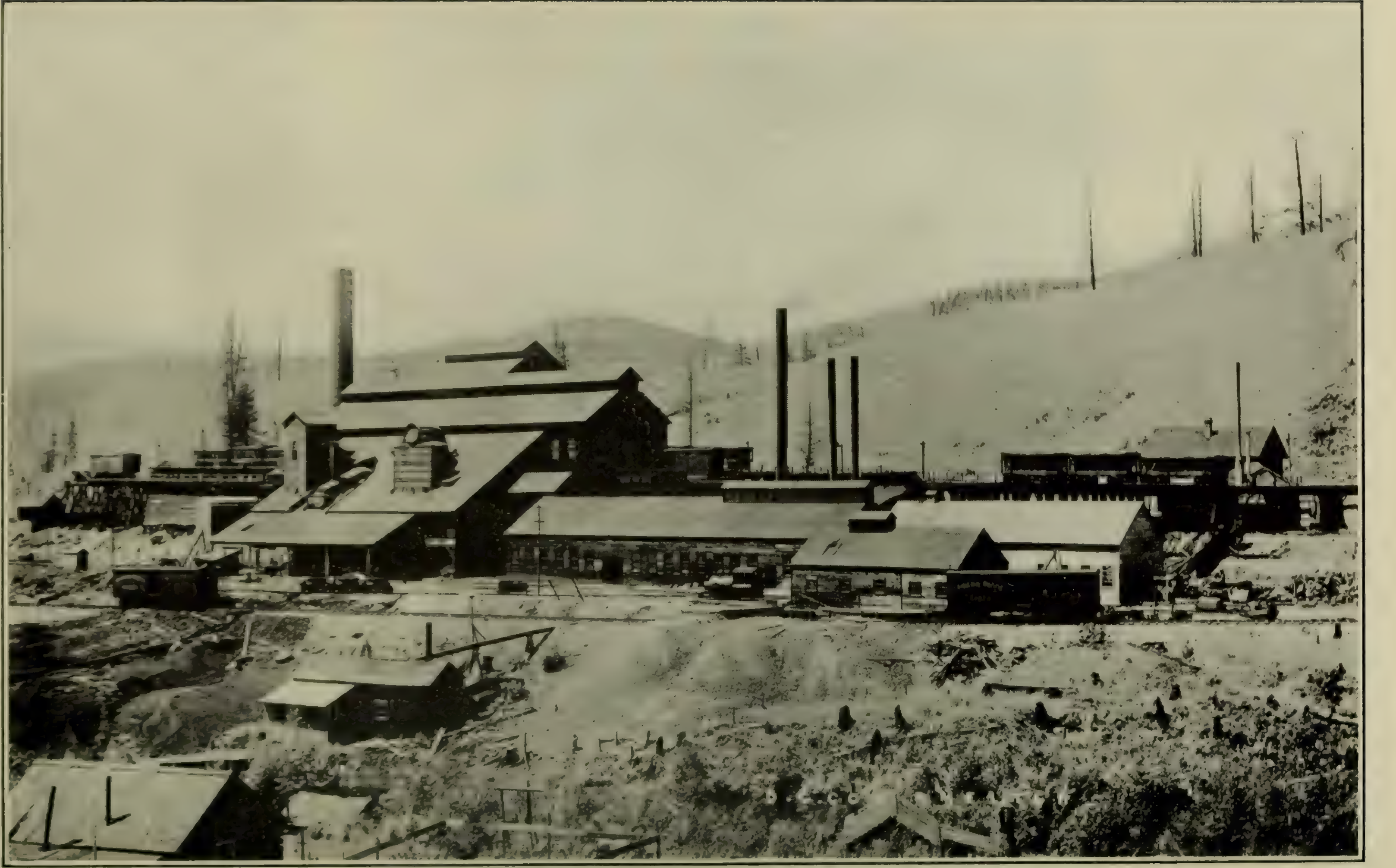
Between the furnaces on the tapping floor, and at each end of the row, are oval settlers (4 in all) each being 4 feet 6 inches deep, and having diameters of 18 feet lengthwise and 10 feet 6 inches across. These huge settlers are lined with chrome fire brick, and are cooled externally by jets of water running down the steel sides. It will be seen that each furnace is thus served by two settlers, admitting of repairs to either without interfering with the work. The settlers at the other plants are much smaller, are water jacketed, and are arranged in pairs or sometimes in sets of three in order to secure good separation of matte from slag. With these large settlers the separation is good when but the one is used.

Slag from the settlers runs into slag cars of a capacity of 25 tons each and fitted with an electric dumping device and air brakes. Electric locomotives draw the cars to the dumps. While a full car is being replaced by an empty one the slag is caught in a ladle mounted on a pillar, which pours its load into the empty car when the latter is placed in position. In the early days of smelting in the Boundary, all the plants granulated their slags, but this practice has everywhere given place to carrying off the molten slag in cars. The slag cars run in a pit on the opposite side of the furnaces from the converter room, and are thus out of the way of other operations.



CONVERTER ROOM, BRITISH COLUMBIA COPPER COMPANY'S SMELTER.

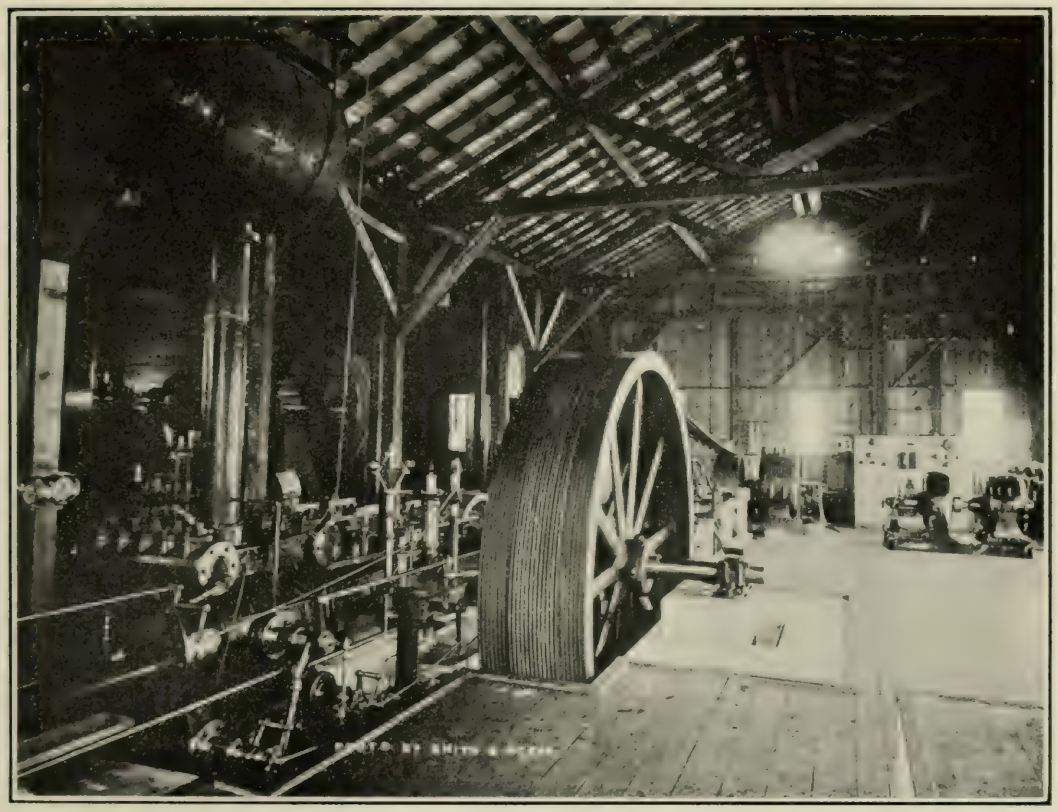
On the converter side of the furnaces, matte is tapped into large ladles and carried by a 40-ton electric crane to the converter. There are two converter stands, and the moment one charge is finished, and while it is being poured off, the other converter is started with a new charge of matte, thus preventing loss of time. Each charge produces from 15 to 30 ingots of blister copper of average weight of 300 pounds, the larger number of bars coming from the last charges when the lining of the shell has been largely fluxed away. The linings are of clay and gold quartz crushed and mixed in a Carlin mill, and are tamped into the converter shells with pneumatic tampers. Each lining will run 3 or 4 charges before being used up. The blister copper produced is exceptionally free from arsenic or other objectionable impurities and runs 99 per cent. fine. Great care is taken to prevent loss of



THE DOMINION COPPER COMPANY'S SMELTER, BOUNDARY FALLS, BRITISH COLUMBIA.

converter flue dust, the flue passing through a large brick settling chamber, in which the gases deposit any dust not caught in the flues. Converter flue dust runs from 65 to 75 per cent. copper, and is recharged into the converters with fresh matte.

The power plant consists of three Roots rotary blowers, each delivering 300 cubic feet of air per revolution, driven by 300 horsepower electric motors. A Nordberg blowing engine, capacity 5000 cubic feet of air per minute and driven by a 300 horse-power motor supplies air to the converters. Two motor generators furnish direct current to the crane and trolley lines, and there are, besides these, electrically driven pumps, air compressor, etc. The entire plant is operated by electric power from Bonnington Falls 80 miles distant.



CONVERTER POWER HOUSE, BRITISH COLUMBIA COPPER COMPANY'S SMELTER.

The new furnace at the Dominion Copper Co.'s plant at Boundary Falls, is the largest in the Province, its dimensions being 48 by 256 inches at the tuyeres. It has also an innovation in the shape of a Giroux hot blast, whereby the blast is heated in pipes arranged about the brick stack above the feed floor. This furnace has been in operation only a few weeks, and is regarded with much interest by those engaged in the industry in the district, but it has not been in blast a sufficient length of time to say whether the hot blast will effect any material saving in fuel, or will increase the capacity of the furnace.

THE OPERATING COSTS AND REVENUE OF URBAN RAILWAYS.

AN ANALYSIS OF THE INTERBOROUGH SYSTEM OF NEW YORK CITY.

By Gerard B. Werner.

This analysis of the last annual report of the Interborough Rapid Transit Company serves a two-fold purpose: it offers an interesting review, on the unit basis, of the operating costs of one of the largest and most involved systems of urban rapid transit in the world, and its comparison of gross and net income shows clearly the enormous inroads on the revenue made by fixed charges in this type of electric-railroad operation. Taken in connection with Mr. Werner's paper in The Engineering Magazine for March, 1907, the information presented cannot fail to be of value in solving problems of electrification on steam railroads, and its consideration of profits will remove much of the popular misapprehension as to the dividend-earning power of this type of public utility.—The Editors.

THE elevated and subway systems of the city of New York offer a representative example of heavy electric traction in large cities. The earnings and expenses of the particular operating company are of course influenced by factors which for the most part are peculiar to the locality. Geographical conditions and the size of the tributary population, among other things, govern the number of passengers carried; and the engineering layout of the power equipment, the efficiency of the management, and especially the fixed charges, affect the cost of carrying the passenger. It is therefore hazardous to attempt to deduce any general laws on this subject from a study of any one system of transit lines. But a peculiar interest attaches to the problem in New York on account of the enormous traffic which this public utility handles, and on account of the size and efficiency of the power stations which supply the motive power. It is with this idea in mind that I have attempted an analysis, on the unit basis, of the report of the Interborough Rapid Transit Company for the year ending June 30, 1906, recently published by the New York State Board of Railroad Commissioners in their annual report.

CHARACTERISTICS OF SYSTEM AND EQUIPMENT.

The Elevated and Subway roads in New York are rather too well-known to warrant any detailed description. A few items, therefore, of the extent and equipment of each are given, which may serve as a basis of reference.

TABLE I. EXTENT AND EQUIPMENT OF LINES.

	Elevated Division.	Subway Division.	Total.
Length of road, miles	37.68	21.79	59.47
Length of single track,* miles	118.05	71.40	189.45
Number of generating stations	1	1	2
Capacity of " "	45,500 K.W.	48,750 K.W.	94,250 K.W.
Number of sub-stations	7	8	15
Capacity of "	61,500 K.W.	64,500 K.W.	126,000 K.W.
Number of passenger cars	1,524	794	2,318
Number of employees	5,476	2,746	8,222
Passenger stations	199	97	296

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* Including sidings and turnouts.

The rolling stock of the Subway consists of both wood and all-steel cars, 51 feet in length, seating 52 passengers. The motor cars of 200 horse-power nominal capacity weigh about 38.3 tons, and the trailers about 25.5 tons.

TRAFFIC.

Of the 820,000,000 passengers carried by all the public transportation lines in the Boroughs of Manhattan and the Bronx during the year ending June 30, 1906, about one-half were handled by the elevated and subway systems. Table II shows the magnitude of the traffic on each of the latter.

TABLE II. TOTAL AND UNIT TRAFFIC.

	Per Year.
Revenue passengers, total	395,716,386
" " elevated	257,796,754
" " subway	137,919,632
Car mileage, total	93,654,185
" " elevated	61,723,112
" " subway	31,931,073
Revenue passengers, per car mile, total	4.23
" " " " " elevated	4.18
" " " " " subway	4.33
Car miles per mile of road, total	1,573,000
" " " " " elevated	1,635,000
" " " " " subway	1,462,000
" " " " of track, total	493,000
" " " " " elevated	523,000
" " " " " subway	447,000
Population, Manhattan and the Bronx	2,500,000
Rides per capita, total	158
" " " elevated	103
" " " subway	55

It will be seen that the passenger density is slightly greater in the Subway, due to the greater volume of travel on that line and perhaps to the fact that the cars are several feet longer than the Manhattan cars. On the other hand, the traffic density per mile is greater on the

Elevated—a fact which may be accounted for through the necessity of running both locals and expresses on the latter over the same tracks for a considerable portion of the runs.

The traffic of the Manhattan Division is handled by multiple-unit trains varying from three to seven cars, while that of the Subway division is taken care of by five- to eight-car trains. The number of motor cars average about 60 per cent of the train composition.

With the average degree of traffic density indicated above, some idea can be formed of the density during the rush hours. During those periods, the Second and Third Avenue trains run on about a 90-second headway; and the Subway trains, express and local, on about a 2-minute headway.

The schedule speeds attained on the various lines vary widely according to the character of the service. The Subway express and local trains approximate 25 and 15 miles per hour, respectively.

Operating Expenses.

It was deemed most suitable for the purposes of the present study to reduce the various items of the annual operating expense account to the car-mile basis, as in this form the figures are more significant than in the total amounts, and offer a more direct basis of comparison.

The account on the opposite page follows pretty closely the form adopted by the Street Railway Accountants' Association of America, and the details chargeable to each item may be found in the Association's report for the year 1905.

The maintenance of track and roadway, in the present instance, seems rather large, amounting as it does to $4,120 per mile of track. But it must be remembered that this item includes the maintenance of the structure, third rail, and interlocking and signal systems, and probably includes betterments or renewals. Of this amount, about $50 may be due to track bonding; about $400 to the working conductor; and the balance to the rails, ties, and structure.

The maintenance of buildings and fixtures includes the power-plant and sub-station buildings.

The total amount for way and structures of 0.996 cents per car mile is 11.10 per cent of the total operating expenses, as compared with an average of 0.98 cents for surface roads with overhead construction.

The maintenance of steam plant takes into account only the mechanical end of the generating stations, such as coal-handling apparatus, boilers, stokers, economizers, heaters, mechanical-draft apparatus, piping, engines, condensers, etc.

TABLE III. OPERATING EXPENSES.

MAINTENANCE OF WAY AND STRUCTURES.

	Cents per car-mile.
Maintenance of track and roadway	0.835
" " buildings and fixtures	0.161
	0.996

MAINTENANCE OF EQUIPMENT.

Maintenance of steam plant	0.126
" " electric plant	0.071
" " cars	0.487
" " electric equipment of cars	0.316
" " miscellaneous equipment	0.001
Miscellaneous shop expenses	0.213
	1.214

OPERATION OF POWER PLANT.

Power-plant wages	0.513
Fuel for power	1.193
Water for power	0.136
Lubricants and waste	0.039
Running expenses of locomotive	0.008
Miscellaneous supplies and expenses	0.076
	1.965

OPERATION OF CARS.

Superintendence of transportation	0.054
Wages of conductors and guards	1.397
" " motormen	0.631
" " miscellaneous car-service employees	0.376
" " station employees	0.907
Car-service supplies	0.056
Miscellaneous car-service expenses	0.248
Station expenses	0.131
	3.800

GENERAL.

Salaries of general officers and clerks	0.2570
Printing and stationery	0.0184
Miscellaneous office expenses	0.0381
" general "	0.0684
Damages	0.2920
Miscellaneous legal expenses	0.2520
Insurance	0.0712
	0.9971

RECAPITULATION.

	Cents per car-mile.	Per cent of operating expenses.	Per cent of gross earnings.
Maintenance of way and structures	0.996	11.10	4.73
" " equipment	1.214	13.54	5.78
Operation of power plant	1.965	21.90	9.36
" " cars	3.800	42.35	18.08
General	0.997	11.11	4.74
Total	8.972	100.00	42.69

The maintenance of electric plant comprehends, besides the electrical end of the generating stations, the sub-station apparatus and the cable work.

The maintenance of cars (the largest item in the maintenance of equipment), 0.487 cents per car mile, amounts to about $196 per car per year.

The maintenance of the electric equipment of cars, including motors, control, heaters and lights, of 0.316 cents per car mile, is $223 per motor car per year. This car-mile cost is low compared to other urban and interurban roads, where this figure reaches 0.7 and 0.8, and averages about 0.60. But the car-year cost is high probably on account of the multiple-unit control and large motors, among other influences. For hand-controlled cars of lighter motor capacity, the car-year maintenance averages about one-half, or $110.

The total amount for maintenance of equipment, of 1.214 cents per car-mile, compares favorably with other electric roads which give an average of 1.50 cents, reaching a maximum of 1.9 cents.

The item power-plant wages includes, besides the labor employed in the generating stations, the labor of the sub-station attendants. Similarly, lubricants, waste and supplies cover the requirements of the sub-stations, so that with the present data there is no means of segregating the proper amount to the generating stations alone.

The item fuel for power, which forms 61 per cent of the total power-plant operation offers a fruitful topic of reflection on what are probably the most efficient power plants extant. Mr. H. G. Stott, superintendent of motive power, has shown[*] that the thermal efficiency of the Interborough plant is 10.3 per cent, with coal of 14,150 B. T. U. per pound. One kilowatt hour, or 3,412 B. T. U. at the bus-bars, therefore, represents 33,100 B. T. U., or 2.34 pounds at the coal pile. Then, if it is remembered that this coal costs in the neighborhood of $3.00[**] per ton, the real significance of the coal bill will be appreciated. Using these figures on the plant economy and cost of coal, the total kilowatt hours generated during the year is then about 320,000,000. The cost of coal per kilowatt hour, therefore, works out to be 0.349 cents. This may be compared with the cost of fuel of 0.55[***] cents per kilowatt hour at the power stations of the Boston Elevated, where coal costs $3.60 per ton.

The total cost of operation of power plant, 1.965 cents per car mile, is correspondingly low, since this item averages about 2.3

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[*] Trans. Am. Inst. Elec. Engrs., Jan. 1906.

[**] Trans. Am. Inst. Elec. Engrs., Jan., 1907.

[***] St. Ry. Journ., Sept. 30, 1905.

cents, with a maximum of about 3.0 cents in smaller and less efficient plants operating under similar conditions. Mr. L. B. Stillwell* is responsible for the statement that "the works-cost of a kilowatt-hour at the bus-bars of the Manhattan plant is less than 0.6 cent" including "fuel, water, labor, maintenance, miscellaneous supplies."

The operation of cars is predominantly a labor charge, and appears surprisingly low when one considers the great number of train men and station employees. This item, 3.800 cents per car mile, may be compared to the corresponding item for a number of typical electric railways which average 5.9 cents per car mile. The operation of the cars in multiple-unit trains contributes to the reduction of the expenses by minimizing the number of motormen required.

The general expenses afford no point of special interest. In passing, it may be remarked that the items under this head are, according to the accounting of the Interstate Commerce Commission, expenditures assignable to fixed charges.

The total operating expense per car mile of 8.97 cents is very low, and illustrates the performance which is attainable with a large and efficient engineering layout and a vigilant management. The operating cost on a number of representative electric roads, elevated and surface, averages about 13.0 cents per car mile, the higher figures representing urban lines. The Brooklyn Heights Railroad (elevated and surface) and the New York City Railway (surface)—to take two specific cases—run up to 14.8 cents and 18.4 cents, respectively.

The operating ratio of 42.69 per cent of the Interborough is correspondingly excellent, compared to the general average which may be expected on transit utilities of about 65 per cent. Last year's operation on the Brooklyn Heights showed a ratio of 55.81 per cent and the New York City, 54.96 per cent.

FIXED CHARGES.

Although the several items under General Expenses might be properly termed fixed charges, the general form of electric-railroad report classifies them under the operating account, and not as a deduction from the gross income.

TABLE IV. FIXED CHARGES.

Interest	0.381 cents per car-mile
Rentals	7.575 " " "
Taxes	1.485 " " "
	9.441 cents per car-mile

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* Trans. Am. Inst. Elec. Engrs., Jan., 1907.

It will be noted that although the interest (on the funded debt) and the taxes (on operating property, structures, earnings and capital stock) are relatively small, the rentals (of leased lines) amount to 85 per cent of the operating expenses. The latter item includes $5,683,680.00 paid to the Manhattan Railway Co., of which $1,809,680.00 appears as interest on the funded debt of that company, and $1,410,476.19 paid to the City of New York as the interest on the city bonds issued for the construction of the Subway.

Income Account.

The abridged income account has been calculated on the car-mile and passenger basis (Table V). As it is practically a *résumé* of the matter which has already been presented in these pages, a few concluding observations may not be impertinent at this juncture.

TABLE V. INCOME ACCOUNT.

	Cents per car-mile.	Cents per passenger.
Gross earnings from operation	21.03	4.98
Less operating expenses (exclusive of taxes)	8.97	2.13
Net earnings from operation	12.06	2.85
Income from other sources*	0.77	.18
Gross income from all sources	12.83	3.03
Deductions from income	9.44	2.23
Net income from all sources	3.39	.80
Dividends	3.09	.73
Surplus	0.30	.07

Conclusion.

Of course, one must be intimately conversant with all conditions to judge properly the financial performance of electric properties. But a number of conclusions are inevitable from even a superficial study of the foregoing figures.

The earnings and dividends of a company operating transit lines in a metropolis like New York are not as inordinately large as the popular impression makes them. Notwithstanding the most economical engineering design and operation and the most able business management, the large fixed charges, especially the rentals in the present instance, operate to cut down the net earnings considerably, and to make the money invested yield only a moderate dividend.

The hesitancy of private capital to undertake the building, equipping and operating of underground lines can be understood when it is remembered that the cost per mile of single track of the present subway was $750,000 for construction, and $380,000 for equipment. In the equipment expenditures, the mile of track cost was $53,000 for the electric line, $78,500 for the power plant, and $113,400 for the cars.*

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* Includes advertising and news privileges; sale of current; rent of land and buildings; telegraph privileges; interest and dividends on securities owned, deposits and loans.

While the maintenance of rolling stock is minimized by up-to-date shop facilities, the labor of inspection is necessarily large. The cost of electrical energy for motive power is reduced through the enormous output of large modern generating stations. The car operation which forms the largest account (42.35 per cent) of the operating expenses, is due to the relatively large number of employees required and the comparatively high wages paid.

The total operating expenses proper are low, notwithstanding the cost of labor and material in the maintenance and operating accounts. Although it is difficult to differentiate one particular cause which is, more than others, contributory to this result, one is inclined to the conclusion that the favorable performance attained per car mile is in part due to the relatively high schedule speeds and daily mileages per car resulting from high-power motor equipments and relatively infrequent stops.

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* Average of $10,200 per car.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By C. U .Carpenter.

VII. MINIMIZING THE TIME OF ASSEMBLING WORK.

Mr. Carpenter's series began in January, and the six articles heretofore presented discussed, first, the general methods of examining into the condition of any manufacturing business so as to discover the existence of waste and loss and to determine the "sticking points"; second, the nature and the working of the "committee system" of factory administration; third, the reorganization of the designing and drafting departments; fourth, the great importance and value of the tool-room as a source and spring of profitable methods; fifth, the general conditions necessary for manufacturing at minimum cost; sixth, methods for fixing standard times for manufacturing operations.—THE EDITORS.

THE study of the proper time in which to do assembling work is peculiarly difficult. It is a far more puzzling proposition than the one of analyzing and determining the proper time in which any particular part should be machined. The element of human judgment and human skill enters so largely into assembling that even the closest study will at times fail to give an altogether scientific analysis of the quickest time in which any particular job should be performed. After a workman has been on an assembling job for a number of years, his operations become automatic and can be made at a rate of speed that cannot be equalled by any man whom the superintendent may elect to "try out" the job unless he has had almost an equal term of experience. A study with the stop watch of the length of time required by the workman will often prove almost fruitless, because if the man has the slightest suspicion that he is being checked up, he will immediately slow his pace. If the job is already on piece work, the proposition becomes an especially difficult one, for the workman well knows how to keep down his rate of production while apparently keeping up a high rate of speed. It is for this reason that the study of assembling work requires particular care and especially keen analysis.

Space prevents any discussion of the essential features of the proper organization of an assembling room at this point. I will, however, emphasize the important feature that in the assembling of articles composed of many intricate parts it is highly advisable to separate the assembling operations for any particular job into as small a number as possible. If the workman can be confined to two, or at the most three, operations the problem is not a difficult one; but where, as in many cases, the assembler will have from eight to ten different operations on a particular part, the solution becomes very difficult to find. Because of this very difficulty, it becomes of extreme importance that some solution be reached, as the waste of time in the ordinary assembling department of the average manufacturing concern is almost beyond belief. The only method of procedure that I have made a success of is as follows:

1. Classify all the work, as was suggested in the case of those parts which are to be machined.

2. Select the most skilful workman in whom you can have confidence. It will be necessary to make him an assistant foreman and hold forth to him promise of future promotion, if the desired results are to be secured. This removes him from the influence of the workmen and has a direct effect upon the problem. The workmen will rarely resent a thorough investigation made by a man under the title of assistant foreman, but will invariably bring severe pressure to bear upon the ordinary workman who attempts such work, in order to force him to use the lowest pace possible without detection.

3. Place before the Committee, the testing assemblers and the head of the assembling room, the different jobs as classified and analyze their elements to the last degree.

4. It would be well at this point to make some close observations upon the workmen who are engaged on this work. It will, however, be necessary to use the stop watch skilfully so that the time required to perform the elements of each operation can be recorded as far as may be possible. With the calculated analyses of the elements of the work, and the actual record as made by the workman, before the Committee, it is then necessary to plan a comprehensive method to be pursued in the testing of the work and in the regular assembling operations to be done by the assembling department in the future.

It will very often be found wise and, in fact necessary to classify the work on the separate jobs in a different manner from that ordinarily pursued, so that each assembler will perform only a portion of the work that he formerly did in its entirety. This action makes it easier to demonstrate to the men that the work can be done within the specified time and also assists in putting it beyond their power to conceal the best results obtainable.

5. In making these tests, it is, of course, essential to surround the tester with the best possible conditions. It is, however, necessary to

keep in mind that your assembling room must be so arranged that the same conditions can prevail in everyday manufacture. These conditions may be specified as follows:

(a) All the work should come to the tester or the assembler properly inspected so that the accuracy of the previous operations can be assured.

(b) All the parts that are to be assembled must be conveniently arranged in logical order. All necessary rivets and screws and tools of all descriptions must be placed at a point convenient to the workman and within his reach so that the least amount of effort is required to handle them.

(c) Wherever possible inspection should provide for such accuracy of parts as to make it unnecessary for the assembler to do any filing or fitting. In every case, however, where such fitting, grinding, or drilling has to be done by the assembler, the necessary machinery for doing the work must be placed as conveniently as possible.

(d) Every possible facility should be provided for the quick handling of the work. In the case of heavy parts, there should be a thorough system of hoists and cranes. The stipulations outlined under the heading of "Handling of Work" will apply here.

A very careful consideration of all of these problems and a serious attempt to solve them scientifically will bring surprising results. I have often noted very large savings in time in assembling operations, which apparently were performed by workmen at a very high rate of speed, working under the piece-work system. A few examples of the benefits of the system advocated, taken from my own experience, may prove of interest at this point.

A few weeks ago, I witnessed an assembling job, the work of which was done according to methods which had been developed under a careful study along the lines advocated. The piece-work price on the assembling work had formerly been $2.85 per piece. The application of these newer methods made it possible for the workman to do the entire assembling job in 16 minutes, and this, too, at a pace which it is perfectly possible for him to maintain during his entire working period.

Some four years ago, I made comprehensive tests in a very large establishment on assembling work requiring a particular degree of expertness and dexterity. Inasmuch as it was impossible to secure one of the trained workmen (numbering in all over 150) who would give his very best efforts to any job that might be set before him, I took a man who was an ordinary truckman, who had never been a mechanic in any sense of the word, and trained him for a period of five weeks before we started him to doing the testing. We naturally selected a man who was particularly bright and capable. I do, however, want to emphasize the point that this particular individual was not a trained mechanic and secured what skill he possessed only during the five weeks training mentioned above.

Allowing that each workman should earn on the average of $3.00 a day, we found that there were 286 jobs that averaged 167 per cent. too high. In other words, for every job that formerly cost $1.00 on piece work, we found the proper price to be about 38 cents. Even then the limit had not been reached, becuse of the fact that the man who was doing the work could not be termed the highest grade of mechanic. We, however, found that after six months had elapsed, he could easily earn $4.00 a day at the prices on the new basis, whereas his former earning had been $3.00 a day. Further investigation showed that in this establishment, where 4,700 men were employed, there were a number of departments where the work was quite similar but where the piece-work prices were all out of proportion, those in one department being greatly in excess of the prices in other departments doing similar work, this being due to the relative efficiency or inefficiency of the foremen in setting prices. We found upon the average that this disproportion amounted to over 23 per cent. The tests mentioned above were performed in one of the departments which was considered the most efficient. In another department—a large polishing room containing 123 men—I found another field for work of the character advocated. These polishers were supposed to be very high grade, their average earning capacity being $4.00 a day. The grinding, polishing and buffing included work upon brass, bronze, copper, sheet steel and cast iron. After the work of investigation had been under way but a short time, a strike occurred. All of the old polishers left in a body. We secured a group of 12 expert polishers from other sections of the country, and then, by offering a high day-work wage rate, we employed 62 men from the adjoining city. It is important to note that these last were men who had never been "up against" a polishing or buffing wheel, and knew absolutely nothing about the trade. Some were clerks from the company's office and others were grocery and dry-goods clerks attracted by the high wage rate. Care was exercised to see that they were strong, healthy and intelligent. Each experienced polisher was placed in complete charge of a group of five of these "green" men. This experienced polisher was under no circumstances allowed to do the work himself, other than to show these men how to do the work and to train them in every possible trick of the trade. Extra rewards were given to these experts to get proper results from the men. In addition to this, the foreman and assistant foreman of the department, together with the writer, were in constant attendance. Unfortunately, my investigation of the elements of this work had been so handicapped by the extra work incidental to the strike that it was impossible to analyze each and every job in the department. The analyses already made, however, showed that a reduction of 40 per cent could easily be made and still provide the men with a large enough price to enable them to earn a good wage. It was our original intention to place the new men upon a day-work system of pay for a period of about eight weeks, the management presuming that very slow progress would be made for this period at the very least, many of the officers indeed claiming that proper results could never be accomplished.

The analyses of operations and the method of training was pursued so vigorously, however, that we found it possible to put the entire body of men upon piece work at the end of three weeks and a half. The new piece-work prices (40 per cent lower than the old ones) were given to these "green" men with the assurance that there would be no reductions made and that the firm would be glad to have them make all the money they could during that period.

The management was careful to see that the former rigid system of inspection was still adhered to in the case of these new men. It is a matter of record that at the end of a period of ten weeks the average earnings of the men of the department exceeded $5.50 per day. The work increased so materially that at the end of six months the actual records showed savings in the pay roll in this department amounting to over $55,000 per year.

Had there been time to make a closer time study, it would have been possible for the firm to save even a larger amount of money with the additional assurance to the workman that he would still have been able to earn a large wage.

These few examples will serve to illustrate the splendid possibilities of the methods and systems advocated.

I shall take up later the question of the system of pay to be used in case of a shop adopting systems described in these articles. It is sufficient to say at this point that I regard it as *absolutely essential that a workman receive a very considerable increase in his daily wage* for accomplishing the very desirable results which can be secured. My object in mentioning this just now is to emphasize the fact that even with the best analyses a workman will become so skilful in time on an assembling job as to exceed to quite a large degree the calculated records, and consequently, in order to secure this extra output, the possibility of which lies hidden within the workman's skill, it is necessary to offer an additional premium.

FOREMEN'S CO-OPERATION.

It has been remarked to me more than once that the most difficult of all the problems connected with the introduction of such systems as those advocated is that of securing the foremen's co-operation. It is undoubtedly true that unless the hearty co-operation of the men operating the departments be secured, the system is almost certain to fail. It is safe to say that it will be almost impossible to introduce these plans in any comprehensive way with a shop organized in the ordinary manner. It is for this reason that I venture continually to bring forth the effectiveness and, indeed, the necessity for the Committees. In securing the foremen's co-operation to these plans, tact must be used. Unless the matter is handled delicately, every one of them will feel that his department is going to be "shown up," and the new record will be compared against his own record to his own disadvantage. Naturally, therefore, this consideration will lead him to covertly oppose the introduction and success of the methods at every point. When, however, these matters are considered in their presence with the Tool Room Committee and the tester, together with the tabulation, they are placed in a position where they must wheel in line and give their support to the system.

By calling all of them constantly into consultation with the Committee, they are placed in a position where they cannot defend any unfair attitude toward these methods. Give them to understand that if they have anything to say in opposition to the plans the committee room is the place to say them and, under no circumstances, tolerate a word of criticism outside of the committee room. If they are made to see that the results are obtained through new methods entirely, and that they are not to be criticized nor held responsible for the results formerly obtained under the old conditions, they will soon lend their enthusiastic support to these plans. Let me again assure any one considering the introduction of these plans that this support is absolutely necessary.

I have always found that if this important question is handled along the lines indicated, and, in addition to this, the foremen are given to understand the success of the system would mean addition to their remuneration, their hearty co-operation will be secured.

EFFICIENCY IN THE BURNING OF FUEL UNDER THE STEAM BOILER.

By William D. Ennis.

III. PRACTICAL MODIFICATIONS AFFECTING THE THEORY OF AIR SUPPLY.

The first part of Mr. Ennis's discussion, which began in our June issue, discussed the necessities of perfect combustion, and explained the bearings of flue-gas analysis. The second installment dealt specially with the measurement and control of draft. The present part takes up the modifications in practical management necessitated by various commercial fuels. Next month Mr. Ennis will demonstrate the economy to be obtained by burning the small grades of anthracite.—THE EDITORS.

THE analysis presented in foregoing articles has dealt primarily (and in theory, entirely) with a fuel assumed to be pure carbon. Certain modifications arise in considering actual fuels. These modifications, in the case of anthracite coal, which is largely pure carbon, are of slight consequence. Soft coal, however, contains a large proportion of oxygen; wood, even more; and both carry rather more hydrogen than hard coal. The presence of these bodies complicates the chemical reactions described as combustion. What are known as hydro-carbons, or combinations of hydrogen and carbon, give to soft coal its peculiar characteristics. These compounds include CH_4, C_2H_4, C_6H_6, C_2H_2 and many others. The reactions which occur in the combustion of the four assumed as typical are;

$$\begin{aligned}
CH_4 + O_4 &= CO_2 + 2H_2O \\
C_2H_4 + O_6 &= 2CO_2 + 2H_2O \\
C_6H_6 + O_{15} &= 6CO_2 + 3H_2O \\
C_2H_2 + O_5 &= 2CO_2 + H_2O
\end{aligned}$$

In general, the carbon and hydrogen separate, the carbon uniting with oxygen to form carbon dioxide (preferably), and the hydrogen uniting with oxygen to form steam. Oxygen is, of course, the prime requisite to combustion, as in the case of pure carbon; but with soft coal or wood, a considerable proportion of this oxygen is contained in the fuel itself, so that a rather smaller amount of air is required from external sources, for complete combustion. The furnace temperatures obtained are somewhat higher. The combustion of hydrogen evolves heat amounting to 62,000 B. T. U. per pound, or more than four times the calorific effect produced by the combustion of one pound of carbon. Even after deducting the latent heat carried off by the steam produced in the combustion of·hydrogen, amounting to 966 × 9 = 8694 B. T. U. per pound of hydrogen burned, the calorific value obtained is very high; and even after some further necessary deductions have been made, to include all the known modifying factors, the available heat per pound of hydrogen is over 40,000 B. T. U.

The combustion of soft coal is still further complicated by the successive reactions occurring in the furnace. When coal is first fired, there begins a rapid evolution of moisture, which breaks up into its constituent elements at a relatively low temperature, the oxygen uniting with carbon to form carbon monoxide (not enough oxygen being supplied to produce dioxide) and the hydrogen being isolated. In order to burn the carbon monoxide to carbon dioxide and the hydrogen to steam, a considerable supply of air must be provided. Under ordinary conditions, no special effort being made to maintain a high furnace temperature, the air supplied does not suffice to consume these valuable gases, for the simple reason that the temperature in the furnace is lower than that at which they will ignite. As a result, dense black smoke is produced, due to the separation of solid particles of carbon and to the evolution of mixed hydrocarbons at temperatures below their igniting points:

$$C + H_2O = CO + 2H$$
$$CO = C + O \text{ (smoke)}$$

As these smoking gases pass away, the temperature of the furnace rises, the carbon burning to carbon dioxide in an adequate supply of air. As soon as the incandescent fuel bed is pretty well burned down, the available supply of carbon for combination is decreased, and unless the ash-pit doors are closed, there is an excess of air passing through the fire. In ordinary operation with soft coal there is, therefore, but one moment when the air supply is ever in proper proportion, viz., when the hydrocarbons and unburnt carbon have passed away and the residual coke is burning freely. In nearly every case an excessive amount of air is provided during the "smoking" period, which fails to prevent smoke because the temperature is too low. This is not an essay on smoke abatement; but as relating to our subject, it should be remembered that while smoke is not usually the result of excess air, it is almost always associated with it.

For the most efficient combustion of soft coal, the air supply and draft should both be varied in accordance with the condition of the fire; the draft should be adjusted so that the distillation of hydrocarbons shall proceed slowly and in a very hot combustion chamber, the intensity of draft being increased after this distillation, while consuming the coke, if desired. If the combustion chamber is kept hot, and the air introduced in such manner as to mingle thoroughly with the burning gases, high economy due to low air excess, and practical smokelessness, are both possible.

The special reactions given, for soft coal, in addition to complicating the analysis of air supply, result in variations of furnace temperature which affect all calculations of gains or losses dependent upon the quantity of air. Thus, in the reaction

$$C + H_2O = CO + 2H$$

there is postulated a separation $H_2O = O + 2H$ antecedent to the one specified. This decomposition, the reverse of combustion, absorbs heat and cools the furnace just as the reaction $H_2 + O = H_2O$ evolves heat, amounting to 62,000 B. T. U. per pound of hydrogen.

Another practical modification of the theories offered is applicable to all fuels, though perhaps most noticeable in the case of the lower grades of soft coal. Analysis of flue gases frequently show the presence in a single sample of oxygen and carbon monoxide concurrently. The question naturally arises, why does not this oxygen unite with the monoxide to form dioxide? Even when the furnace temperature is beyond any question high enough to ignite carbon monoxide, it is not at all unusual to find fairly large percentages of this gas, unconsumed, when the air supply is entirely adequate. This phenomenon is to be explained by the failure of the gases to mix thoroughly in the furnace. There is a strong tendency for these gases to stratify, probably on account of their different densities, and this overcomes the effect of impact at the corners and angles of the combustion chamber which naturally would have a tendency to bring the gases into contact.

Arguments in favor of using pulverized coal for fuel are based on the necessarily perfect mixing of air and gas from the fuel which occurs when the latter is blown into a furnace. The necessity for more thorough mixture is recognized also in the various devices for smoke prevention involving contracted passages, baffle and wing walls, and the like.

Incomplete mixture is of course ignored in the various charts herewith presented. The figures for loss of fuel due to various percentages of carbon dioxide are based on the assumption that all oxygen present in the gas has united with carbon to the full extent of the valency of the former. If air is in excess, but carbon monoxide is nevertheless present, then the monoxide contains some of the oxygen that would otherwise be found in a free state. Suppose we assume, for one pound of pure carbon, an air supply of x pounds, of which .23 x pounds is oxygen and .77 x pounds nitrogen. Let y be the weight of carbon burned to dioxide, then $1 - y$ = weight burned to monoxide. The oxygen supplied in the two cases respectively will be 2.67 y and $1.33\ (1 - y)$. The flue-gas composition would then be as follows:

Carbon dioxide, $y + 2.67\ y = 3.67\ y$

Carbon monoxide, $(1 - y) + 1.33\ (1 - y) = 2.33\ (1 - y)$

Oxygen, $.23\ x - 2.67\ y - 1.33\ (1 - y)$.

The total weight of the products of combustion is the same as in our first analysis, $(1 + x)$ pounds. The weight of dioxide being 3.67 y pounds, the proportion of carbon dioxide in the gases is:

$$A = 3.67\ y \div (1 + x) \qquad (1)$$

The proportionate loss due to excess air has already been expressed by the formula

$$(x - 11.6)\ (t' - t^\circ)\ (.2375).$$

Putting this equal to B, and letting $(t' - t^\circ) = 500$, we have:

$$14{,}500\ B = 118.75\ (x - 11.6)$$

$$\text{whence} \qquad x = 122\ B + 11.6 \qquad (2)$$

Substituting this value of x in equation (1), we obtain, finally:

$$B = (y \div 33.2\ A) - .103 \qquad (3)$$

The value of B for the condition of perfect mixture, would be

$$B = (1 \div 33.2\ A) - .103 \qquad (4)$$

We may readily confirm this by assuming that $x = 11.6$, whence $A = .291$ and $B = 0$, as it should. The difference between the second terms of equations (3) and (4) represents the difference in loss due to heating excess air under the conditions of either partial or complete mixture, as related to the percentage of carbon, dioxide in the gases. This difference is expressed by

$$C = \frac{1 - y}{33.2\ A} \qquad (5)$$

This expression is positive for all possible values of y, and we note therefore that the percentage of fuel lost by heating excess air is less than that shown on the chart, Figure 2,* for any specified percentage of dioxide.

There is, however, a definite loss due to incomplete mixture, which tends to offset (and usually does offset) this technical gain. We have seen that (1 — y) pounds of the fuel are burned to carbon monoxide, involving a loss of (1 — y) (14,500 — 4,400) B. T. U. The loss bears the proportion to the total fuel heating value of

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* THE ENGINEERING MAGAZINE, June, 1907, page 425.

$$\frac{10{,}100\ (1 - y)}{14{,}500}$$

If we set this quantity equal to the expression (5), we find $A = .0433$, or at that percentage of carbon dioxide equal to 4.33 per cent of the total weight of gas, the reduction of loss in heating excess air is counterbalanced by the loss due to the production of carbon monoxide. If A is increased, B decreases; and vice versa; so that when the percentage of carbon dioxide is greater than 4.33, the total net result is an increase of loss; when less than 4.33 per cent, the net result is a decrease of loss. These modifications give the dotted curves of Chart II, crossing the main curve at the point where carbon dioxide amounts to 4.33 per cent of the total weight. This would be reduced to percentage by volume in plotting the curve as described below.

This modification of the theory of loss ignores the fact that incomplete mixture always tends to excessive decrease of furnace temperature, both on account of the excess air and by reason of the formation of carbon monoxide. With the furnace temperature considered, there can be no question but that incomplete mixture always increases the amount of fuel wasted; and even if this factor be neglected, the variation in loss from that shown by the main curves of Chart II, is so slight that the steam producer cannot form any other than a purely technical exception to the validity of that curve.

To reduce the percentages by weight to those by volume, for $CO_2 = 4.33$ per cent, we find $y = .0118\ (x + 1)$.

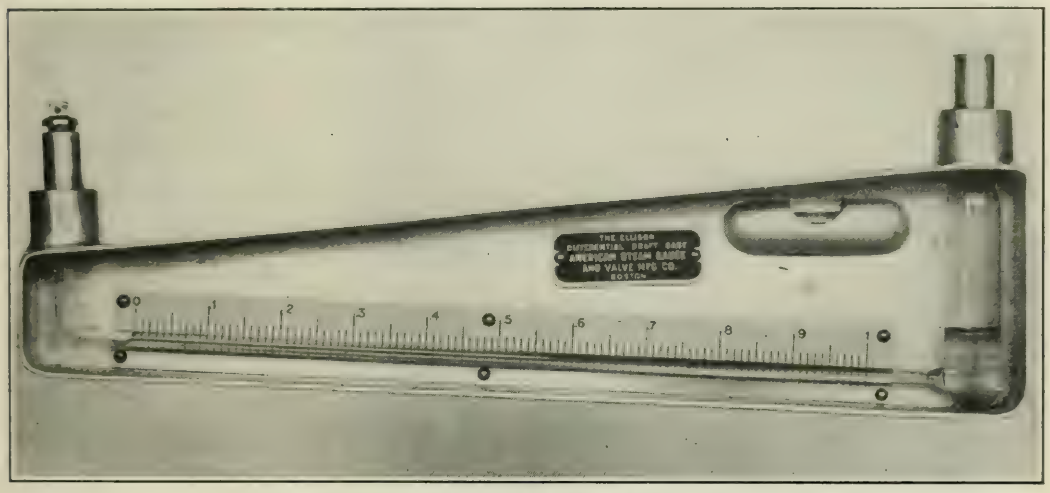
Gas.	Weight.	Relative Volume.	Actual Volume.
Carbon dioxide	$.0433\ (x + 1)$	.0909	$.00393\ (x + 1)$
Carbon monoxide	$2.29 - .0275x$	.143	$.328 - .0039x$
Oxygen	$.216x - 1.273$	.125	$.027x - .159$
Nitrogen	$.77x$	.143	$.11x$
Total..............	$(x + 1)$ approximately		$.137x + .173$

The ratio of carbon, dioxide to total gas volume is, therefore

$$.00393\ (x + 1) \div (.137x + .173)$$

which, for values of x above 1, amounts practically to .0287. The percentage 2.87 therefore represents the crossing line of the main and dotted curves of Chart II. So low a percentage of dioxide is seldom found in practice concurrently with monoxide and free oxygen, so that generally speaking the presence simultaneously of these last two gases is an indication of losses greater than the theoretical for all ordinary percentages of carbon dioxide.

There is a further modification of the theory, from which it is not so easy to escape, and which may offset our having thus far ignored the wastes due to lessened furnace temperatures. We have heretofore, in calculating the excess air losses, taken the specific heat of the products of combustion at .2375. This is the correct figure for air at constant pressure within usual ranges of temperature. For such high temperatures as are found in boiler furnaces, it is probably too low. We know that the specific heats of steam and other gases increase with the temperature. If this is true also of air, then the theoretically possible temperature of the furnace will be lowered and the loss due to excess air increased.

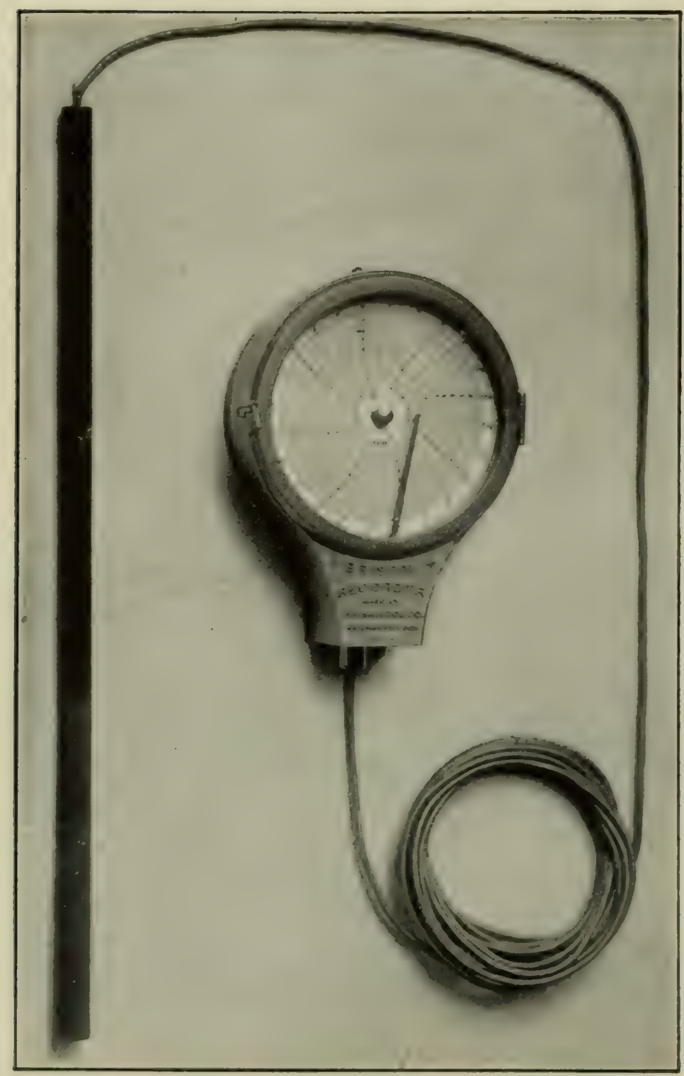


ELLISON DIFFERENTIAL DRAFT-GAUGE.

Designed by Lewis M. Ellison and manufactured by the American Steam Gauge & Valve Co., of Boston. Made right and left hand, the largest (3-in.) size having a 15-in. scale, 20 divisions to inch. Reads either pressure or vacuum, according to which end is connected with the flue or furnace. The liquid used is mineral seal oil.

Further, the various gases present during combustion differ slightly in specific heat. The specific heat of carbon dioxide is given as .217; of steam, .475; nitrogen, .245. These differences of specific heat modify slightly the calculations as to the temperature attainable in the furnace and the loss due to excess air; but the modification is not more than a very slight one, in the latter case.

Another more significant factor is the phenomenon of dissociation. It has been found that gases partially decompose, absorbing heat, at temperatures far below those at which their constituent elements will unite in combustion, evolving heat. Thus, carbon dioxide begins to break up into carbon and oxygen at a temperature of about 2,100 degrees; steam similarly breaks up into hydrogen and oxygen at about



BRISTOL RECORDING THERMOMETERS, FOR CONTINUOUS REGISTRY OF FLUE TEMPERATURES.

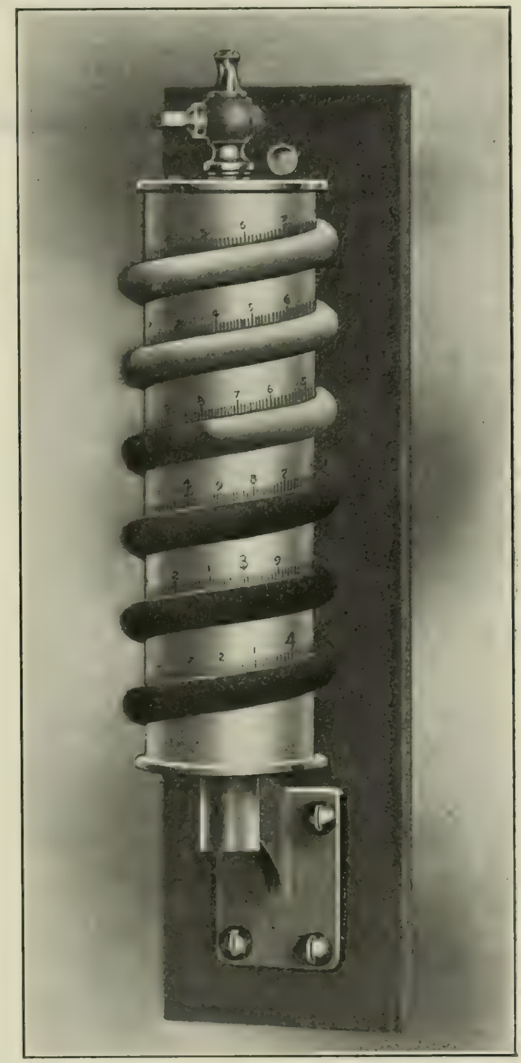
The instrument is a delicate gas pyrometer, the changes in the registering bulb being transmitted any ordinary distance through the small tube to the recording dial. The Bristol Company, Waterbury, Conn.

the same temperature. Fortunately, however, the amount of decomposition thus occurring is small, being alalogous to the evaporation of water into invisible vapor at temperatures below the boiling point. So far as it occurs, however, this decomposition in the furnace is a source of loss; just as much heat being reabsorbed and carried off by the separation of dioxide into its constituents as was evolved by the union of those constituents.

The modifying effect of various fuel constituents other than carbon, hydrogen, and oxygen, has not been considered. The most important of these constituents is sulphur; but as percentages of sulphur above 2 per cent render the fuel unfit for use in steam-boiler furnaces, the practical consequences of the presence of sulphur are slight.

With the high furnace temperatures necessary for high economy, as evidenced by the foregoing analysis, it is obvious that radiation losses from the furnace and setting will be increased. To hesitate on this account from getting the highest possible temperature would logically lead eventually to putting the fire out as the most economical step possible. That high percentages of carbon dioxide, and the compact fire with the limited air supply necessary therefor, may result in some increase of loss due to unburnt fuel in the ash is probable; but as the total loss to the ash need not exceed 2½ per cent, it is of small importance as compared with the losses due to excess air.

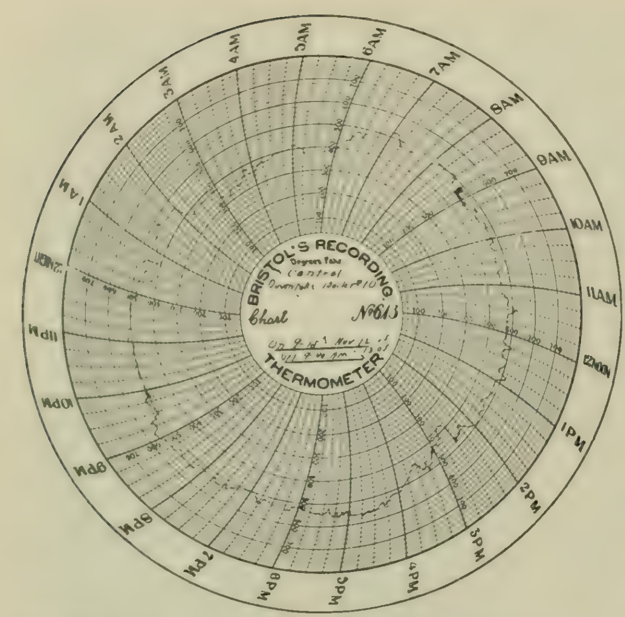
High rate of combustion appear to be most conducive to high percentages of dioxide. This is no doubt partly due to the difficulty of cutting down the air supply to a sufficiently low point. Dampers, ash-pit doors and brick settings always leak more or less, and sometimes it seems as if the air were able to go straight through sound brick and mortar. Being unable to get the quantity of air reduced to where it should be, we do the next best thing, and increase the amount of coal until it begins to correspond with the air supply. Consequently, highest economy is now secured, with soft coal, at a combustion rate of 25 to 30 pounds, whereas a few years ago it was thought that 16 to 18 pounds was the maximum rate permissible. We may eventually find that there is a most efficient rate of combustion for each coal, depending on the limiting thicknesses of fire, under practicable conditions of cleaning, with regard to avoiding holes in the fuel bed. Such most efficient rate of combustion will certainly be higher than those formerly suggested.



SARGENT DRAFT-GAUGE.

Direct-reading, with 6-in. range reading to 0.01 in. The helical tube is celluloid, surrounding a nickel-plated brass cylinder. The liquid is water. Sargent Steam Meter Co., Chicago.

An important note should be made here. With high rates of combustion, we must be careful not to advance beyond the capacity of the boiler heating surface to absorb the heat generated from the coal. The old ratios of heating surface to grate surface will probably have to be revised, if in the future we are to work at



RECORD OF FLUE TEMPERATURES MADE WITH A BRISTOL RECORDING THERMOMETER.

combustion rates of 25 pounds and upward. A high rate of evaporation per square foot of heating surface, beyond a rather uncertain limit, will certainly be detrimental to both economy and capacity. Our boilers must be large in proportion to the grates, and—a matter of even greater importance — the gases must be so baffled as to come into contact with every square foot of the heating surface, without the short circuiting usual in horizontal and some types of water-tube boilers. High combustion rates no doubt give some gain by reason of crowding the gases, and to a certain extent, compelling them to mix; but we must not abandon other methods of producing the most thorough mixture possible and of bringing the gas into contact with every foot of every tube in the boiler.

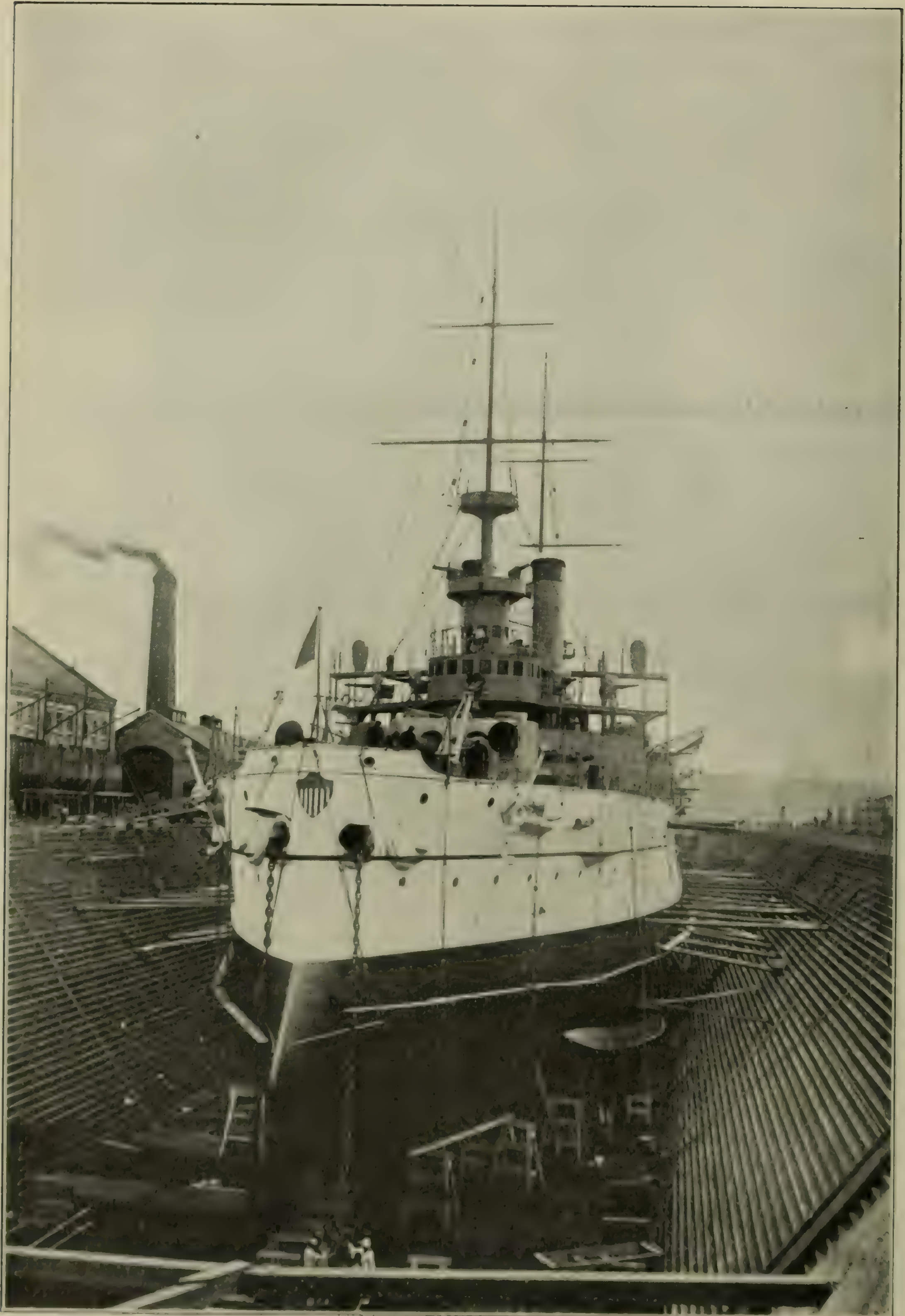
High rates of combustion and high percentages of dioxide may result, under present conditions of boiler design, in increased escaping temperatures of flue gases. The loss of heat due to such increased temperature is proportioned to the amount of air supplied. To cut down the air supply from 23.2 pounds to 11.6 pounds would result in a sufficient saving to permit of doubling the temperature of escaping gases. There is little danger that the gain due to decreased air supply will be greatly reduced by reason of losses due to increased flue gas temperatures.

Such intensified combustion may increase boiler repairs; but the objection thus raised against a normal and reasonable air supply is kindred to that made on account of increased radiation loss. Our boiler repairs would be least if the boilers were not operated at all. If they must be operated, then operate them to the best advantage. It is my belief, founded upon observation of plants in many industries and using nearly every kind of fuel, that the average loss of fuel due to excess air alone would pay the expense of replacing the boilers every year or eighteen months.

Close regulation of air supply increases the tendency to smoke production. This cannot be gainsaid. Nevertheless the plants which are economical with regard to air supply are not the smoke-producing plants. The closer attention to furnace operation which is essential to correction of air supply involves control of those factors which tend to produce smoke. If smoke production were inseparable from diminished air supply, this would be of economical consequence only where smoke constitutes an hygienic menace. The losses due to smoke are insignificant as compared with those due to excess air. The presence of smoke is, however, an indication that something is wrong with the air supply; and as this error is almost always in the direction of excess, smoke is usually significant of important losses. As we have seen, the smoke-producing fuels require, not an increased air supply, but an adjustment of air supply to the changing conditions of the fire, an unusually perfect mixture of gases, and a continuously high furnace temperature.

The question may be asked, why is any excess of air necessary? Under the best operation yet recorded, an excess of air of about 30 per cent is found. Why should this excess exist? The explanation lies in the difficulty of mixing the gases. There is always some stratification, always some layers of oxygen which have failed to enter into combination. We must therefore provide such excess as will cover this loss of available oxygen, and the loss as yet has not been brought below 30 per cent. Possibly it may eventually be reduced by improved furnaces and combustion chambers, which will deflect and commingle the flames. The resulting furnace temperatures will be higher, and more destructive to grates and firebricks; but as conditions demand it, methods of design and materials of construction will be found to meet those conditions.

It would be a most desirable thing to fit up an experimental boiler with which these subjects might be investigated with such degree of thoroughness as their importance justifies. No manufacturer or power producer is willing to carry on experimental work unless comparatively quick results are probable. Ways and means of further reducing air supply and abating smoke must therefore be sought in the laboratory. A test boiler of moderate size, fitted with fuel, water, and air-weighing and analyzing equipment of perfect accuracy, and equipped with time and labor-saving devices to permit of continuous operation by one or two men, might lead to results that would have a bearing on furnace design and the operations of combustion, corresponding to that which the classic experiments of Isherwood have had on the design and operation of the steam engine.



U. S. S. WISCONSIN IN THE DRY-DOCK, BREMERTON.

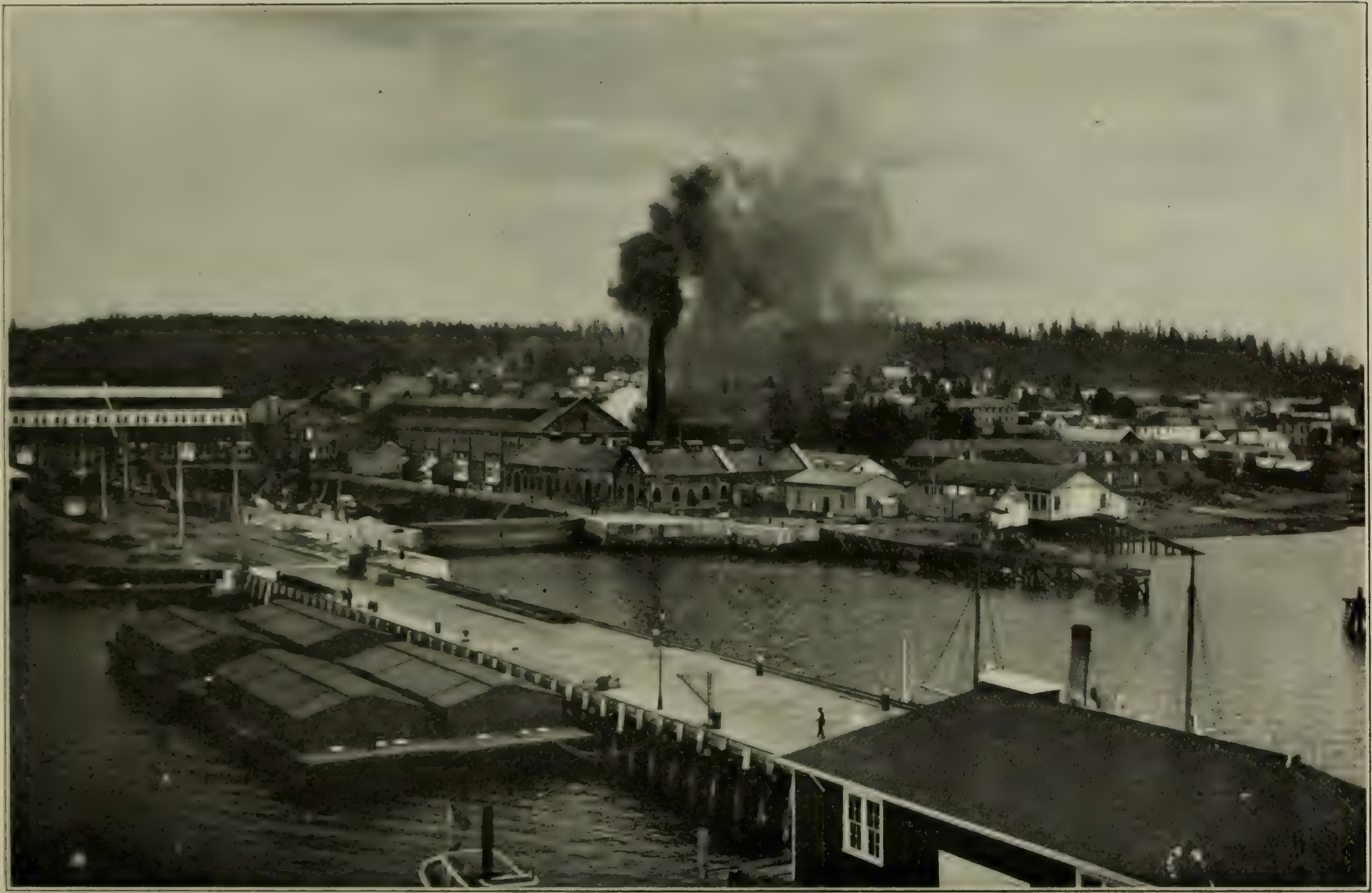
THE POSITION AND EQUIPMENT OF THE PUGET SOUND NAVY YARD.

By H. Cole Estep.

The exploitation of any present possibilities of war with Japan belongs to the sensation monger. We can not believe that the situation existing, even if difficult, will be so handled by either government that any but a peaceful solution will be reached. But it is certain nevertheless that the future interests of the United States, both commercial and military, will be increasingly concentrated on the Pacific; and now that attention is drawn that way, even if over-feverishly, the season is timely for this study of the resources by which America could hope to maintain an effective fighting force for the defence and support of her western coasts and Far Eastern possessions. Mr. Estep's study is based on the latest data and on observations on the ground, but just completed.—THE EDITORS.

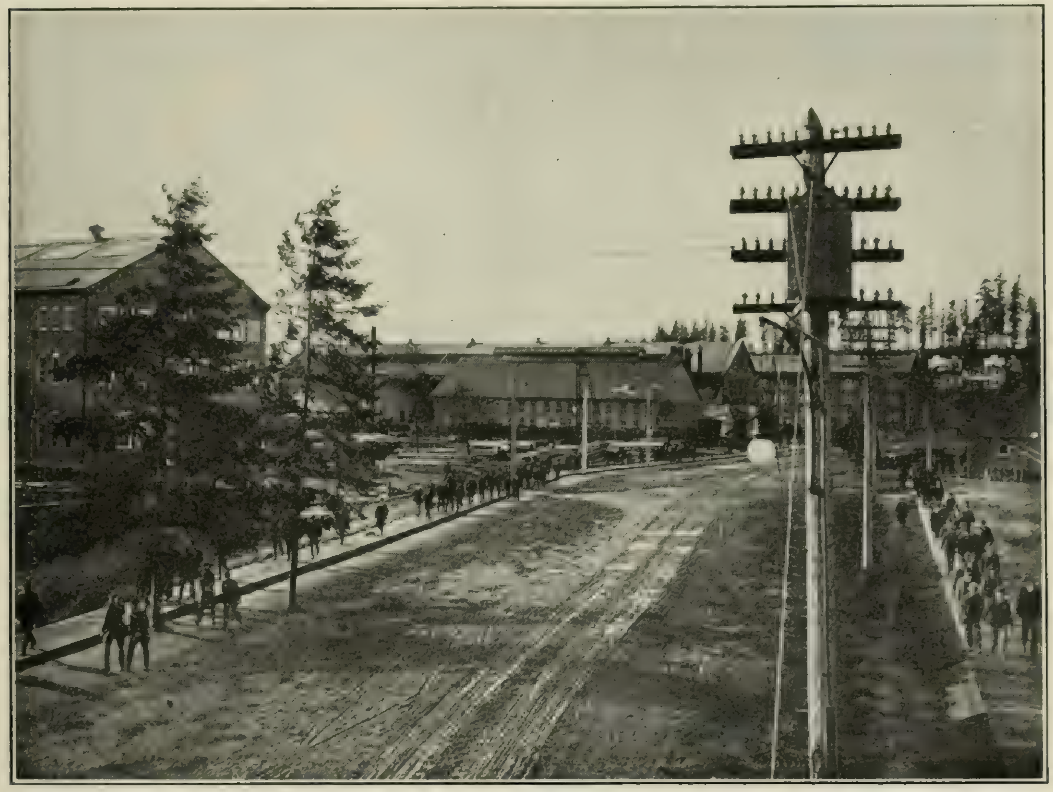
EVERY person of ordinary intelligence realizes that the efficiency of the navy depends as much upon the maintenance of a system of well distributed, serviceable repair and equipment stations as it does upon keeping in commission a large and effectively disciplined fleet of fighting ships. Appreciating the truth of this, the Navy Department of the United States has entered upon a policy of using a large portion of the naval appropriation for the construction and improvement of navy yards and Congress has from time to time wisely appropriated special funds for this purpose. In the near future more money than ever before will be spent on building new, and improving the old, navy yards. Connected with these expenditures are several important questions regarding their proper administration. One of the most vital of these is the question where the improvements shall be made and upon what particular stations the bulk of the money shall be spent. Should most of the new dry-docks and repair facilities be established on the Atlantic or the Pacific coast, and if on the latter, where? It is for the investigation of this question that this paper is written.

It is the opinion of a number of naval experts that New York and the other important navy yards of the Atlantic coast are, for the present at least, sufficiently well equipped already and that the energies of the Department should be spent in improving the facilities on the Pacific. It has come to be a trite saying that the naval battles of the future will be fought on the Pacific Ocean. The ever present and apparently growing friction with the Japanese which presages



GENERAL VIEW OF PUGET SOUND NAVY YARD AND DRY-DOCK. TOWN OF BREMERTON IN THE BACKGROUND.

war either in the immediate or distant future, the continual delicacy and complexity of conditions in the Far East, as well as our own extensive and valuable island possessions in the Pacific, all point to the truth of the above statement. The completion of the Panama Canal will be of material aid in concentrating the American fleet on the Pacific Ocean should the occasion arise, but even with the Canal in operation the dry-docks of the Atlantic are too far away and too difficult of access to be of any use. Dependence for repairs and dry-docking facilities must be placed upon the naval stations located on the Pacific coast of the United States. It is vitally important that these stations be thoroughly and completely equipped. Are they?



THE MAIN ENTRANCE TO THE PUGET SOUND NAVY YARD, BREMERTON.

There are but two navy yards of any importance located on the Pacific coast, situated respectively at Mare Island, near San Francisco, California, and at Bremerton on Puget Sound near Seattle, Washington. Without intending to belittle in any way the efficiency and importance of the Mare Island Navy Yard we must recognize that its situation is unfortunate at the best. The channel leading to the yard is shallow. Ships leaving the dry-dock, outward bound, have got their sea valves and bottoms full of mud.* A large, new dry-dock is being constructed at Mare Island, but on account of the early trou-

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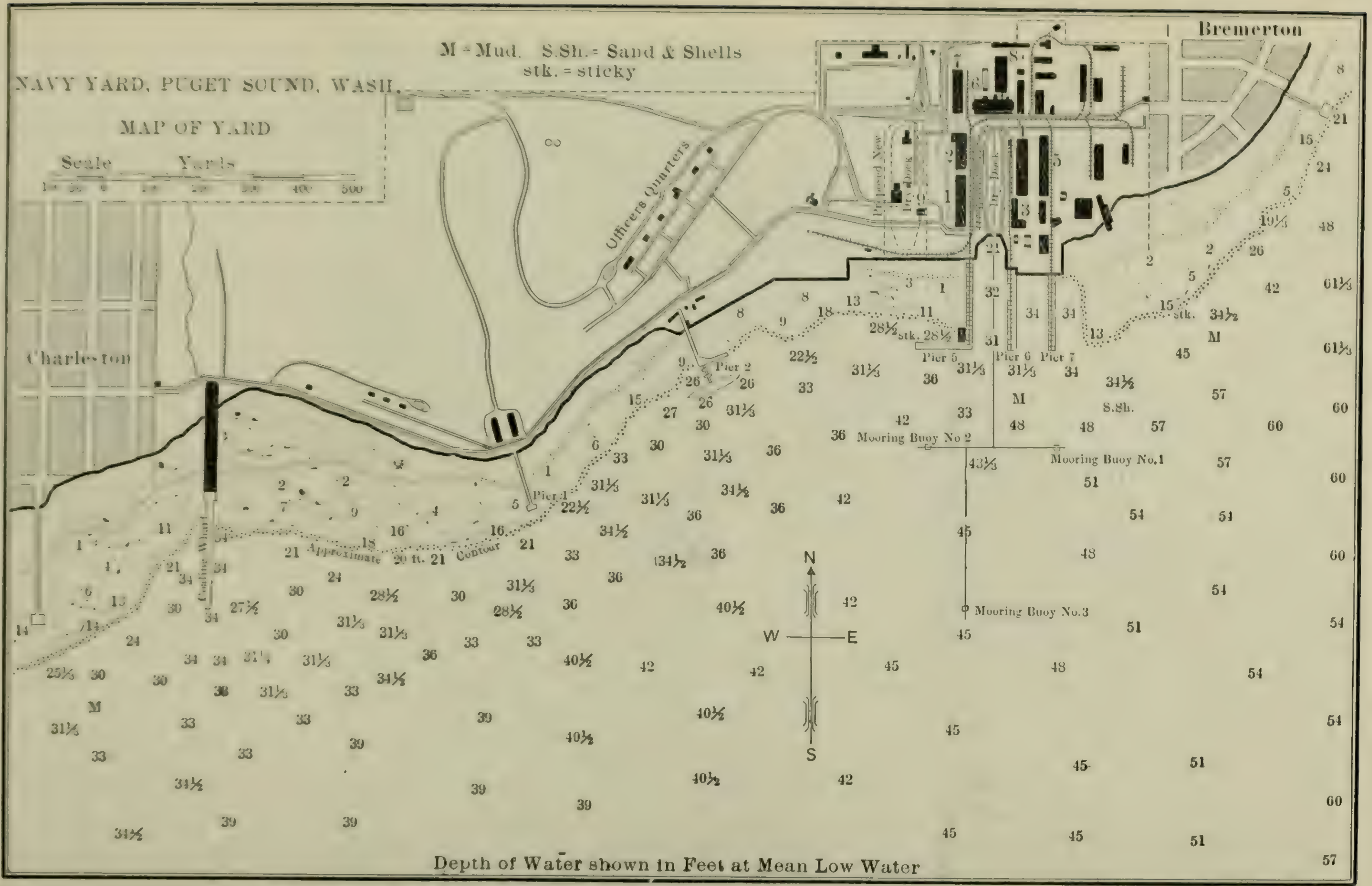
* We understand the channel improvements made by Admiral Rousseau have corrected much of this trouble.—Ed.

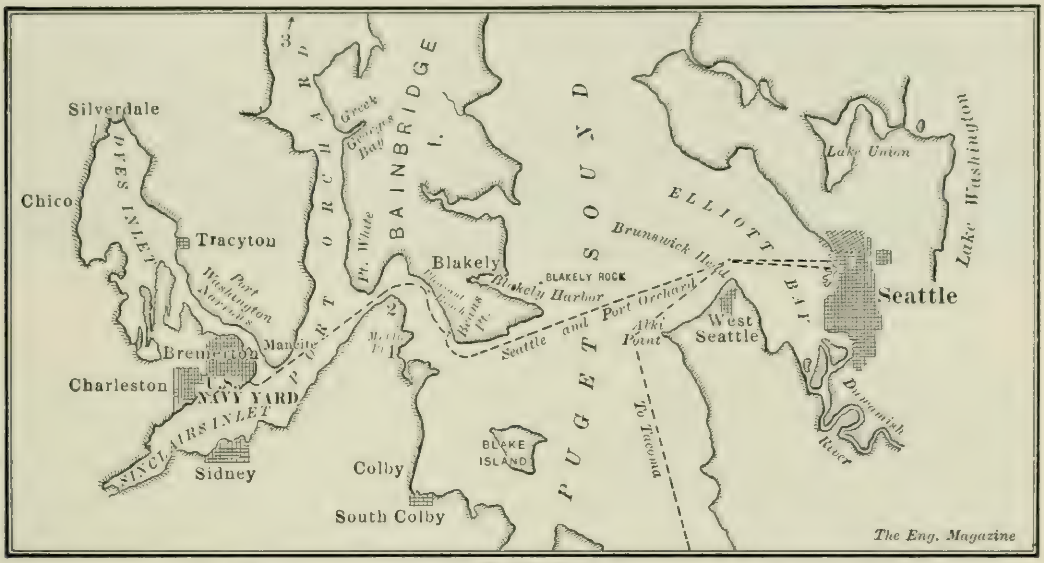


1- Boat Shop. 2- Equipment Bld. 3- Pumping Plant. 4- Machine Shop. 5- Ship Fitters' Shed. 6- Machine Shop. 7- Boiler Shop. 8- Foundry. 9- Office.

PUGET SOUND NAVY YARD, SHOWING GENERAL ARRANGEMENT AND CHART OF SOUNDINGS.

bles with the foundations its completion will require some time yet. At present the dock is too small to handle large ships, being approximately half the size of the Bremerton dock.

There is then at present but one dry-dock on the whole Pacific coast that could be used in case of immediate necessity for docking and repairing the largest battleships, of the "Wisconsin" and "Nebraska" type. It is the dock at Bremerton. Inasmuch as we have found that this dock is the only adequate one at present and that for some time to come the Pacific fleets must depend on the Puget Sound Navy Yard, and upon that alone, for repairs, we will investigate this yard more in detail. Is it properly located, well protected and thoroughly equipped; if not, what is lacking?



1- .Fort Ward 2- Rich's Passage 3-Agate Pass

MAP SHOWING GEOGRAPHICAL AND STRATEGIC POSITION OF PUGET SOUND NAVY YARD.

The Puget Sound Navy Yard is located at the head of Port Orchard, an inlet from Puget Sound, in Kitsap County, Washington. The yard is approximately 130 statute miles from the open sea; is 2,400 miles from Honolulu, 4,000 miles from Panama, and 6,000 miles from Manila. It can be said without exaggeration that the yard is the best situated naval station in the world. The site, which was originally selected by Lieut. A. B. Wyckoff, U. S. N., in 1880, lies on the shores of Sinclair Inlet at the extreme southern end of Port Orchard. It is 16 miles from Seattle. There are two channels leading from the main sound to the navy yard, one from the north through Agate Pass and the other from the east through Rich's Passage. The Agate Pass route is too shallow for anything but shallow-draught sound steamers, while the Rich's Passage channel is deep and wide enough for the largest battleship, five fathoms being depth at the

GREAT NORTHERN STEAMSHIP COMPANY'S S. S. DAKOTA IN THE BREMERTON DRY-DOCK.

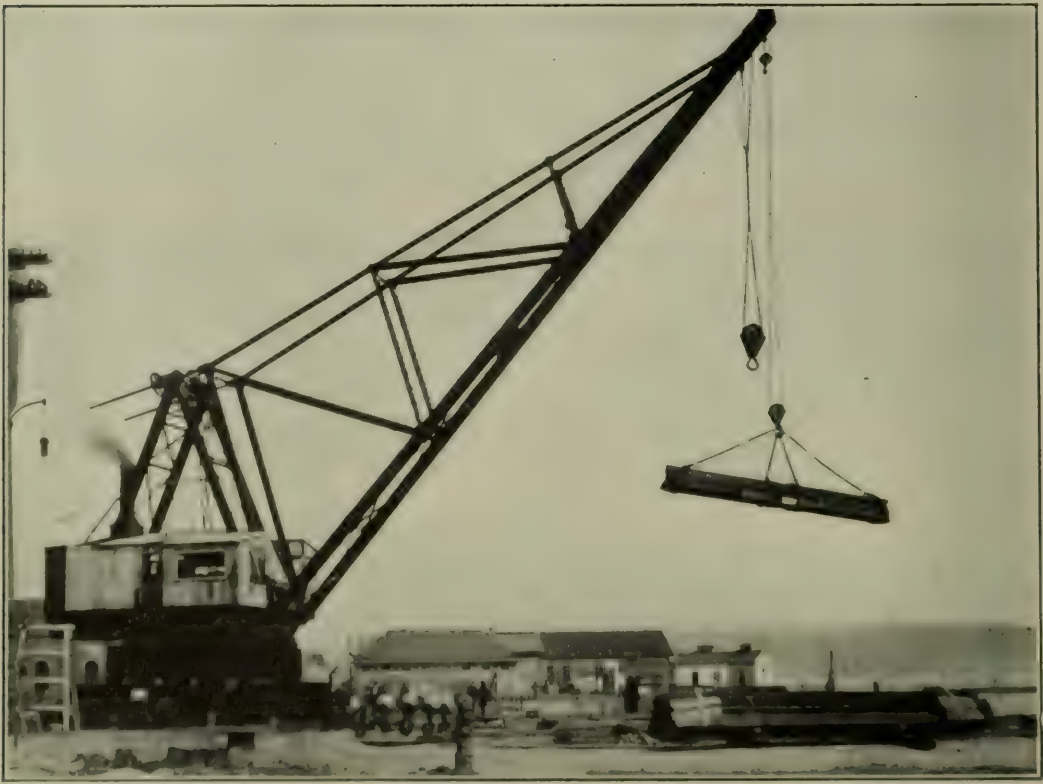
She taxed its capacity to the utmost.

shallowest point at mean low tide. The bottom is coarse gravel. Except by a long detour around the head of the Sound the navy yard is unapproachable from the land side. The yard has no railroad connections except by means of car ferries operated from Seattle. This has proven to be somewhat awkward in the handling of heavy machinery and guns, but the invariably calm water between Seattle and Bremerton makes the operation of car ferries and barges a simple matter. The mean change of tide at Bremerton is 7.97 feet. The bottom of the bay descends quite rapidly to a depth at mean low tide of 30 feet, sufficient to float the largest man-of-war. After reaching this depth the bed of the bay descends slowly to the middle where a depth of 60 feet is reached. The tidal currents are scarcely perceptible, while those encountered in entering and leaving through Rich's Passage are well-known and harmless. Port Orchard Bay, the harbor in front of the navy yard, covers an area of about three square miles, thus affording secure anchorage, with excellent holding ground in from six to eight fathoms, for at least fifty men-of-war. The yard is located at some distance from any commercial ports so the use of the harbor will never be interfered with by merchant vessels. The bay is closely land-locked, the only entrance to it being a channel not over a half a mile wide. The high hills and bluffs that surround this channel afford ample protection against storms. Violent winds never occur in this region, and the waters of the bay are at all times so quiet that even small craft such as row boats and small launches are secure. At the extreme head of the bay, about three miles distant, is a very small stream of fresh water. This water is clear and no sediment whatever reaches the harbor. It was these facts that lead Lieut. Wyckoff, Captain Mahan and others to select this spot for a large navy yard. Admiral Bradford, U. S. N., has summed up the situation thus:

> "There is but one good harbor on the Pacific coast in American territory and that is Puget Sound. If you travel thence southward you will have to go clear to Mexico to find a harbor which, like Puget Sound, is safe and reliable at all seasons of the year, at all stages of the tide and during all kinds of weather.
>
> "The dangers to navigation at the entrance to the bay of San Francisco are well known to nautical men. So also are those at the mouth of the Columbia River. Battleships of the larger class have no access either to Portland or to the Government dry-dock at Mare Island. We can get into Port Orchard in all kinds of weather. The naval station at Bremerton is far enough removed from the boundary line to make it safe for the repair and equipment of vessels of the United States navy even in time of war. Because of the depth of water, the shelter from storms, and its easy access from the ocean, the Puget Sound Navy Yard has paramount advantages."

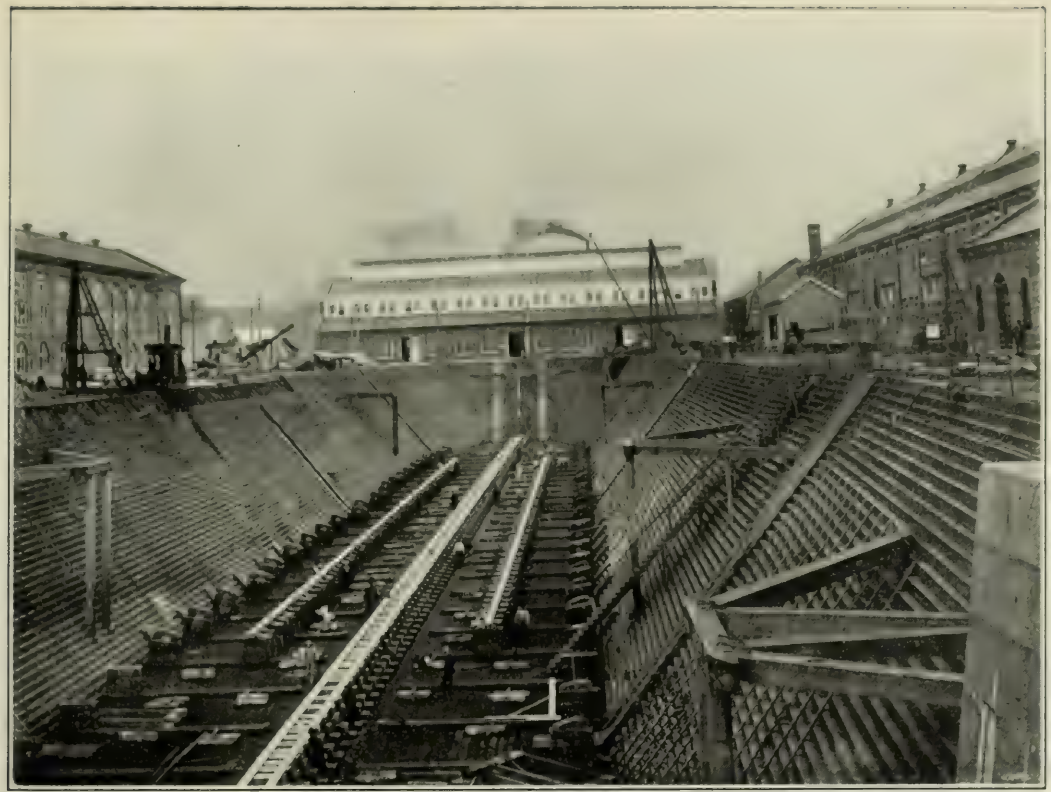
REPAIRING THE PIER JUST SOUTH OF THE DRY-DOCK.

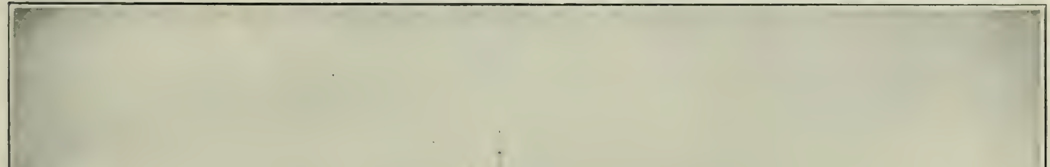
On account of its situation the yard would be practically impregnable in time of war. Three distinct systems of forts have been established for its protection. They are Forts Flagler, Casey, and Worden near the entrance to Puget Sound, Fort Lawton on Magnolia bluff just north of Seattle, and Fort Ward situated on both sides of the channel at the entrance to Rich's Passage. The passage in front of Fort Ward is one mile wide, but on account of the Orchard rocks, located a quarter of a mile from the east shore, the width of the channel is but half a mile. About a mile from the entrance are located the narrows and here the main channel is but 440 yards wide. From this it appears that the problem of effective protection is a simple matter. Rich's Passage is the only way by which the navy yard could be reached by a hostile fleet. We have seen from the foregoing that so far as situation is concerned the Puget Sound Navy Yard is unrivalled. We shall now turn to the matter of equipment.



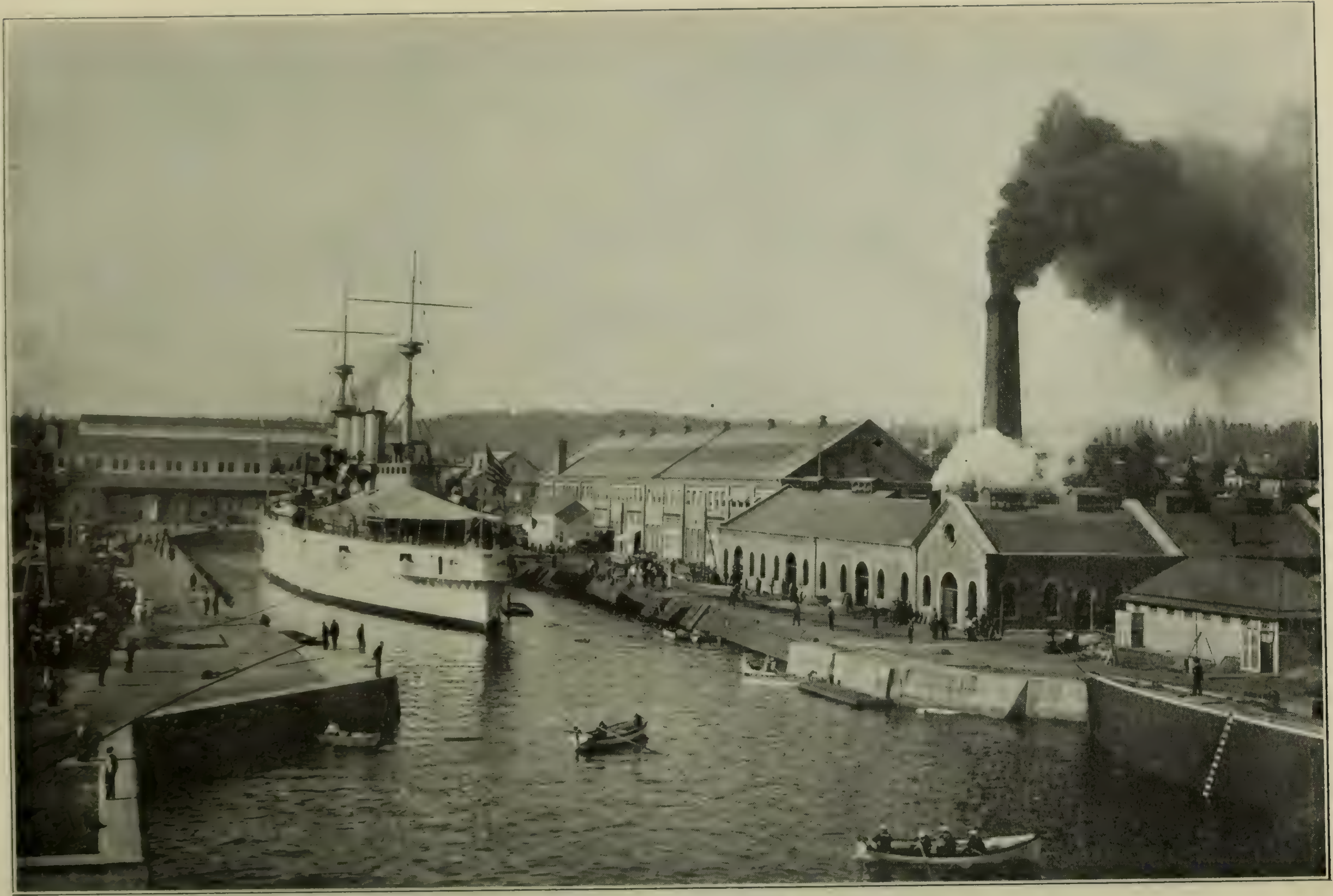
THE 40-TON CRANE SERVING THE DRY-DOCK.

The yard covers an area of 200 acres and employs an average force of 630 men. The present dry-dock is constructed with a concrete bottom, wooden sides, and concrete coping. Its length is 650 feet, width at top 130 feet, at bottom 67 feet, and depth 39 feet. It cost $700,000 and is the third largest in the world. An efficient pumping plant is maintained in connection with the dock. There are two ma-





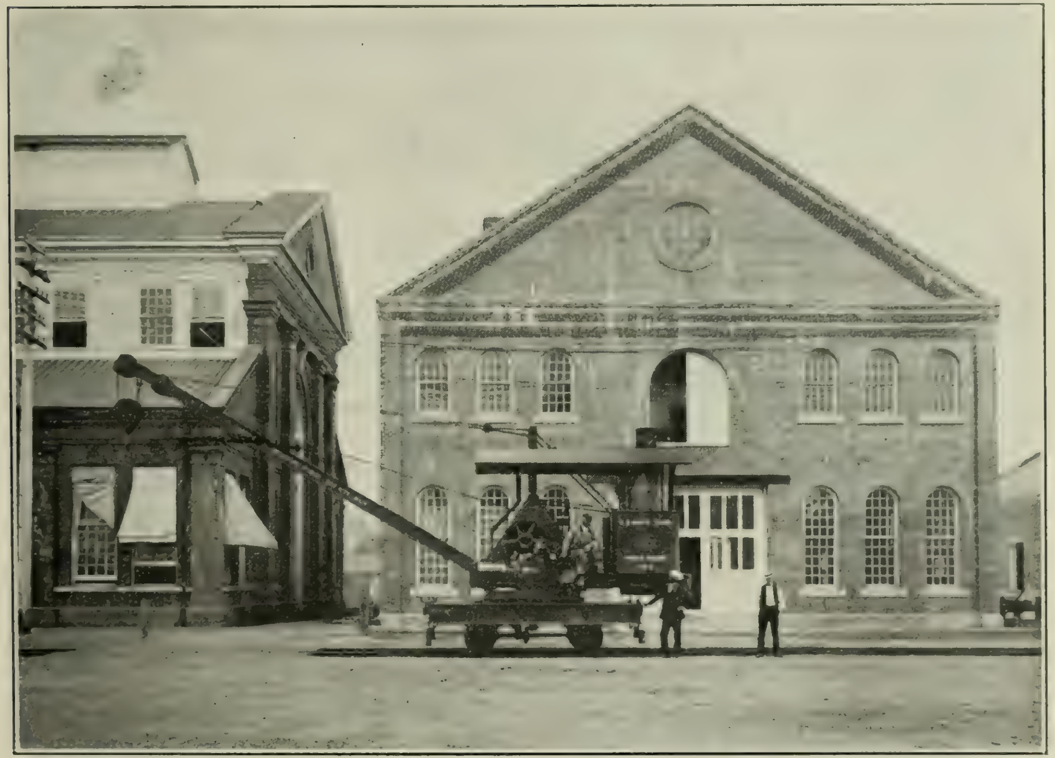
THE LOWER VIEW SHOWS THE FILLING OF THE DRY-DOCK PREPARATORY TO DOCKING THE U. S. BATTLESHIP NEBRASKA. THE UPPER, TAKEN IN THE OPPOSITE DIRECTION INSIDE THE PONTOON, SHOWS THE DOCK EMPTY.



U. S. S. NEW YORK IN THE DRY-DOCK AT BREMERTON.

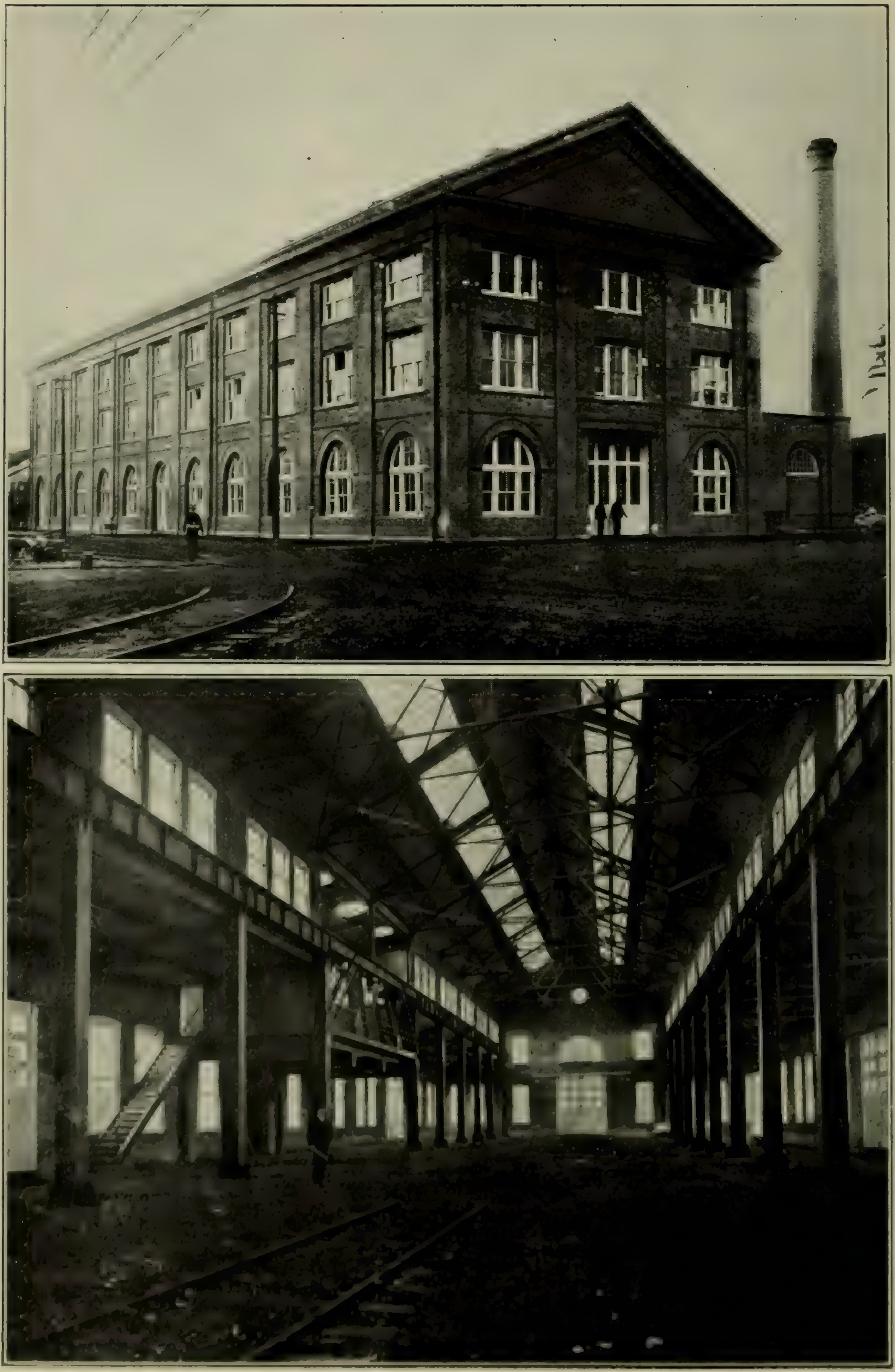
The dock was being pumped out when the photograph was taken. The pumping station and the construction and repair department machine shop are seen on the right.

chine shops. The larger, belonging to the department of steam engineering, is 200 feet by 96 feet and is fitted with an ample equipment of heavy machine tools. The shops are motor-driven on the group system, but there is no central power station. There is also a forge shop and foundry similar in size and adequacy of equipment to the machine shops. All these shops are well designed and placed and are fitted with traveling cranes and other devices for the rapid and economical handling of heavy materials. In addition to the metal-working shops there is a corresponding equipment of wood-working shops, a boat shop, a paint shop, and an equipment building. The yard is provided with a standard-gauge railway, which together with a 40-ton and several smaller jib cranes serving the dry-dock, affords an effective and efficient system of internal transportation. The total investment in the navy yard is $3,000,000. In general the present equipment, as far as it goes, is complete, serviceable, and efficient.



SMALL PORTABLE CRANE IN FRONT OF THE SHEET-METAL SHOP.

But has the United States Government gone far enough? Are two navy yards, each small compared with the great plants on the Atlantic, with only one dry-dock large enough to hold a battleship, sufficient for the important and growing needs of the Pacific? Every person at all familiar with the situation thinks not. The Bremerton plant, being the more favorably located, should be doubled in size. In case of any trouble in the near future, the Pacific fleets with only



EXTERIOR AND INTERIOR OF THE EQUIPMENT BUILDING, PUGET SOUND NAVY YARD.

OFFICERS' QUARTERS IN WINTER, PUGET SOUND NAVY YARD.

one adequate, well-protected dry-dock at their disposal would be seriously handicapped. In view of the present delicacy of the Japanese situation this lack of sufficient repair facilities might result in disaster. Some steps have been taken to improve matters. The construction of a new concrete dry-dock at the Puget Sound Navy Yard, to cost $1,500,000 and to be 750 feet long, has been authorized. Construction will begin immediately, but it will be several years before this dock is finished. Aside from this, but few improvements are contemplated. There is needed to put this station in a position to do the work that at any time may be required of it an additional expenditure of $7,000,000, including a large floating crane, a marine railway for small vessels, a central power station to replace the present uneconomical system of separate plants, and about double the present equipment of foundry, forge, machine and wood-shop facilities.

If these improvements were made the naval stations of the Pacific coast would be equal to any emergency. It is essential to the welfare and safety of the United States that this be done and that the Pacific coast be provided with navy yards commensurate with its importance as a theatre for naval operations.

THE VALUE OF THE INDICATOR IN REFRIGERATION WORK.

By Dr. Joseph H. Hart.

THE value of the indicator in steam-engine design and operation is well-known. It is in common use in valve setting and in the determination of the efficiency of a steam engine. The form of the indicator diagram, the meaning of the various parts of the curve, and the significance of variations from the standard type are more or less familiar to all, if the application is to the steam engine. But in its application to the compressor—with ammonia or carbon dioxide, as used in refrigeration, or with air in the many industrial applications of compressed air—it is not so universal in its utilization. Indeed, many refrigerating-machine manufacturers regard its use as absolutely unnecessary in the setting up and regulating of their machinery and advocate the thermometer as thoroughly efficient and quite sufficient for their work. Even some text books on the use of the indicator make an equivalent statement in regard to this one of its applications. Most engineers, however, who are thoroughly familiar with this instrument both from a theoretical and practical viewpoint are in accord in regard to its usefulness in this field.

There is no doubt that the indicator, or rather the indicator diagram, is just as useful in refrigeration as it is in steam-engine work. Its limitations here are its limitations in steam-engine work as well. There it merely records variations in pressure in the cylinder in conjunction with variations in cylinder volume as dependent on the stroke of the piston. It performs the same function in its application to the ammonia compressor. In steam-engine work it takes no account of the temperature of the steam except as this can be deduced as a function of the pressure and volume. Nothing can be learned from it about the degree of superheat in the steam, the amount of moisture in it, or the quantity of steam which passes through the cylinder at each stroke of the piston. In the same way there can be obtained from it in its application to the ammonia compressor nothing concerning the degree of superheat in the ammonia gas, or its temperature or the amount of liquid or vapor carried over in the gas or evaporated in the compressor itself. Many of these latter points can be obtained, or at least approximately calculated, from the thermometer reading, in both steam and ammonia work. The fact that these latter properties have a much greater significance in refrigeration than in steam and power production is the excuse for the ordinary opinion. Steam is never supposed to enter the cylinder partially condensed, and the object of all work is to avoid this condition as much as possible and to use only dry and superheated steam. In refrigeration, however, especially in wet compression, a special feature is made of the advent of liquid ammonia into the cylinder chamber and its further evaporation therein, partially or completely, as the result of the heating produced by compression. These variations are all due to the fact that in steam work the effort is always to keep the heat in the cylinder, whereas in ammonia work the object is to get it out of the cylinder as fast as it is produced.

These conditions give, of course, an entirely different conception of the indicator work and its relative importance in the two cases. In the first case, in the steam engine, *work* is the object to be obtained and heat is of minor significance. In the second case, that of ammonia compression, *heat* (or rather its removal, producing refrigeration) is the important factor, and work becomes of minor significance. The indicator diagram is essentially a work instrument, and only to the extent that work is important is this development important. The indicator performs precisely the same duty in the two cases. It is invaluable in valve setting, in both steam and ammonia work, and no adequate conception of either the steam engine or the ammonia compressor as a machine can be obtained without its use. Knowledge in regard to pressure in both cases and total work done in expansion and compression can be obtained in no other way. Of course, if it makes no difference what quantity of work is done by the compressor in refrigeration, or what amount of steam is used, the indicator is not necessary. If refrigeration only is considered the thermometer is quite sufficient. The same data can be obtained in steam work from the use of thermometers and by measuring the water consumption of the engine as can be obtained by the use of the thermometer and by metering the ammonia, which is done practically by measuring the refrigeration produced in the cooling coils. It can be stated as a general fact that the compressor as an efficient machine from a work point of view has not been sufficiently regarded by refrigerating-machine manufacturers, and hence the low estimate in which the indicator and its usefulness in this field are held. There is no doubt that an increase in its use would result in an increased efficiency in all plants when such diagrams are taken regularly and studied to show what improvements are possible and desirable.

Now in order to understand its significance in this work we will take up and discuss the standard diagram and its meaning in compression, and also state the significance of the usual variations from this type, paying particular attention to its relation to the thermometer and temperature and refrigeration throughout this development. In order to do this more thoroughly and to understand its various features more clearly, we will take up the steam diagram at the same time and point out the analogies and contrasts between the two throughout the entire cycle. The general shape of the diagrams in the two cases is the same. In both these should consist of the two horizontal lines one above the other, the lower always being longer than the upper and the two connected on one side by a vertical line and on the other by a curved line, curving toward the lower straight line. The object in steam work is to get the greatest amount of work for the least steam consumption; in compression, on the other hand, to get the greatest amount of compression for the least work done. Now the upper straight line in the steam diagram represents the portion of the stroke during which steam enters the cylinder, and its distance from the lower line represents its pressure above that of the exhaust. Hence this must be as far above the lower line as possible, or the pressure of the entering steam must be as high as possible, in order to get the greatest amount of work; and the line must be as short as possible, as its length is always proportional to the amount of steam that enters the cylinder per stroke of the piston. Of course, the area of the diagram represents work, being equal to the pressure times the change in volume, and by making the upper line longer, we get a larger area and hence more work done per stroke of the piston, but we use more steam and the object is to get ordinarily the greatest proportionate amount of work from the steam. In overloads, of course, the time of cut-off is extended and we have varying lengths of cut-off, often automatically regulated by the governor, so that the engine runs uniformly independent of the load. In these cases, the engine does more work, but it uses a much larger proportionate amount of steam and its efficiency is lowered. In the best engines, the cut-off is made to operate under normal circumstances so that the greatest proportionate amount of work is accomplished at the best efficiency from a steam-consumption point of view. This is the same as saying that the rest of the curves in the diagram are so proportioned and have such relations that with this particular length of the upper line, or steam consumption, the greatest area, or work done relatively, is obtained. The remainder of the expansion after the cut-off should be adiabatic for most efficient work. In other words, the remainder of the upper line in the indicator diagram should be part of an adiabatic curve. An adiabatic line is steeper than an isothermal, and hence the latter would give a larger area to the diagram and therefore more work, but in this case heat would have to be added during this change and this extra heat would not be utilized at its best efficiency. In practice the curve is even steeper than an adiabatic, on account of the cylinder condensation and the accompanying loss of heat. Steam-jacketing the cylinder is done sometimes to eliminate the cylinder condensation and this tends to make the curve isothermal as well, but the full result is never obtained in practice.

Now in the compression diagram, on the other hand, the upper half represents the compression part of the stroke. The ammonia gas or air is compressed adiabatically until the other valve opens, and during the remainder of the stroke the line should be horizontal while the gas is leaving the compressor and entering the condenser. In the compression diagram the length of the upper horizontal line is proportional to the quantity of ammonia gas leaving the compressor, and hence is proportional to the refrigeration produced. The area of the diagram is, of course, the work done on the gas by the compressor, so the object in this application is to get the upper line as long as possible. The area of the diagram becomes less the nearer the upper line is to the lower, or the nearer the condensing pressure is to the suction pressure. The colder the condensing water and the larger the condenser, the less will be this pressure; therefore this development explains the reason and the manner in which the temperature affects the efficiency of the plant and the amount of work required in refrigeration. Of course, if the upper straight line is not horizontal but continues to rise with further compression, it means that the condenser is too small to take the extra charge from the compressor without extra work, and this represents a cut in efficiency also, since the pressure at which the valve opens is the pressure at which the condenser can work if its capacity is not overcrowded. Further, the compression up to this point is generally adiabatic, since all the work done on the gas appears as heat in it, and this has little chance to escape. The adiabatic curve is steeper than an isothermal, and hence in order that the area in the diagram, or the work done, shall be a minimum, it is desirable that this compression be isothermal, and the temperature of the ammonia gas should not be allowed to rise during compression. This is the object sought by water-jacketing the compressor, and the efficiency of the water jacket can be readily observed from this curve in the indicator diagram. Also, the speed of the compressor very materially affects this line and hence the efficiency. If the compressor is operated too rapidly, the heat cannot escape from the gas to the water jacket fast enough and the curve becomes adiabatic and more work is done. A much more serious difficulty is encountered here owing to the fact that the entering cold gas on the next stroke rapidly reabsorbs this heat from the cylinder walls and expands back into the cooling coils before the valves are closed, and this results in a loss in refrigeration due to a diminution in the capacity of the condenser, since this effect is apparent in a change of density and temperature rather than of pressure, and the indicator diagram does not show it. An analogous effect is present in the steam engine, and it explains why increase in speed tends toward an increase in efficiency in the steam engine, whereas in the compressor the action is reversed. Thus, the indicator diagram becomes further an invaluable criterion in the regulation of the speed of the ammonia compressor so as to get the best results.

Of course, in practice, every ammonia compressor is run at its maximum operating speed in order to increase the capacity to its maximum irrespective of efficiency so as to decrease the relative value of the first-cost factor; but every operator should know the speed beyond which excess refrigeration can be produced only at a loss, even when all factors are considered, and this can be known only by deductions from the indicator diagram.

We have considered now only conditions in refrigeration similar to those in steam engineering—assuming a dry gas only in both cases, and not a condensable vapor or one containing liquid in minute particles, or with liquid in the cylinder. The consideration of these features materially alters the conditions to be considered and affects the form of the indicator diagram in a manner that is easily understood and recognizable. What has been stated is essentially true for the process known as "dry compression," in refrigeration. Now in "wet compression" a variable amount of liquid ammonia is drawn into the cylinder along with the suction. The first result of this operation is of course the fact that the cylinder volume available for gas to be compressed has been diminished by the volume of the liquid in the cylinder. The upper horizontal line in the indicator diagram is no longer proportional to the quantity of gas compressed in the cylinder per stroke, if this is measured in volumes, as in the previous case with constant condensing pressure. The object of this injection of liquid into the compressor is the elimination of the reheating effect from the cylinder walls. This is not eliminated, however, but is present in both cases and is probably even more pronounced in wet compression. In dry compression, the capacity of the compressor may be cut as much as 20 per cent on account of this development. As has been said, this effect is present not as an increase in pressure due to the heating, but as a rise in temperature followed by a diminution in density at constant pressure and cannot be detected on the indicator card. In wet compression, a portion of the liquid is evaporated immediately on its entrance into the cylinder and the gas thus produced still further diminishes the available volume of the cylinder for gas coming from the cooling coils. However, the compression then occurs at a rather low temperature and with a much higher density for the compressed gas, and hence occurs with an increased quantity of gas. The extent to which these two opposing tendencies counterbalance each other is not known. The relative efficiency of wet and dry compression is still a matter of much debate and is not settled conclusively. If the water jacket, however, is not very efficient in its removal of the heat from the cylinder, in dry compression the effect becomes cumulative with increase in speed, whereas in wet compression this additive effect is not present and much higher speeds can be obtained theoretically if just the proper amount of liquid for cooling is injected with each stroke of the piston. The compression curve, even in the diagram for wet compression, is below the adiabatic and approximates an isothermal. Less work should be done per stroke by this method and the relative efficiency of the work in the two cases only is in question.

Now to consider the remainder of the diagrams in steam and refrigeration and their relative significance: this includes merely the lower limb of the cycle in both cases, and in steam work corresponds to the exhaust stroke and the return to the boiler pressure, while in refrigeration it consists of the suction part of the cycle and the effect of clearance on the lowering of the pressure in the cylinder to that in the cooling coils. In steam the area enclosed in the diagram must be as large as possible and this is assisted by having the lower line as far as possible from the upper line. This merely means that the exhaust pressure should be as low as possible for best efficiency. The lower line should be horizontal, because a rise means loss in area or a diminution of the available work. A slope in the line may be due to a number of causes. The condenser may not have sufficient capacity, or the condensing water may be too hot for rapid work, and thus the advent of the additional steam may raise the pressure. It may mean also that the exhaust ports are too small, or the pipes too narrow, or that the valves are stiff or operating wrongly, and the form of this line combined with the remainder of the diagram enables the engineer to diagnose the particular difficulty with facility. The remainder of the line should be vertical and appear only at the end of the stroke when the pressure changes to boiler pressure again. Any variation from this vertical line means a loss in efficiency due to the slow motion or inertia of the valves, or to errors in the proper size of the ports and pipes, or to leakage at the valve seat during a part of the stroke, or possibly wrong time of closing the exhaust valves.

All these causes can be readily identified as variations and combinations of variations in the form of the diagram. In compression, on the other hand, the lower line involves in its vertical component the expansion of the gas which remains in the cylinder after the compression is finished and is known technically as the "clearance gas." Then follows the opening of the suction valve and the horizontal line of suction pressure. The greatest efficiency is obtained when this line is very close to the upper line, since then the area is smallest, or the work done is at a minimum. This result is obtained best with a high suction pressure, but this latter depends on the temperature of the boiling ammonia in the cooling coils; hence we see why the efficiency depends directly on the temperature which must be maintained in the refrigerator, and why the more extreme the refrigeration required, the less will be the efficiency of the process. The lower line should be horizontal. Any lowering of this line means increased work on account of stiff valves, insufficient ports or pipes, or an insufficient capacity in the cooling coils. The clearance line should be vertical and denotes then a complete absence of ammonia remaining in the cylinder from the compression stroke. If this line curves over it means abnormal clearance or leaky valves on the pressure side. Of course, less work is then done in a cycle since the enclosed area is smaller, but some of the work is always in this case repeated work and the efficiency is diminished. The effect of the clearance is simply the same as having a spring between piston and piston head. Work is lost here and is apparent as extra heat in both cases.

We have completed now the cycle of the indicator diagram in refrigeration. Its usefulness extends over a wide range and a large amount of knowledge thus becomes available in regard to the internal behavior of the compressor and conditions governing its efficiency. Of course, the chief use of the indicator is in valve setting. A slight change in the position of the eccentric makes variations in the times of operation of the valves which very materially affect the efficiency. A complete study of valve mechanism and operation is not only possible with this diagram, but it constitutes the chief and best method for getting the best efficiency and proper operation in this department.

Whenever density and temperature enter as variables, often with variation in pressure or volume, the indicator fails to show significant changes in the form of the diagram. Operated in conjunction with thermometers (or rather thermometers and throttling carlorimeters) to get percentage of vapor or liquid in ammonia gas and temperatures, the combination is capable of giving nearly all the known or knowable facts about refrigeration and the action of compressors. Separated, each of these instruments is inadequate, but combined they are wholly sufficient. The use of indicators in refrigeration is a practice that should be encouraged, but their limitations without the thermometer should be recognized, and the limitations of the latter without the former should also be known.

THE IMPROVEMENT OF OPPORTUNITY FOR THE YOUNG WORKMAN.

By George Frederick Stratton.

The threatened difficulty of finding an adequate supply of skilled mechanics to carry on the engineering industries of the future has been repeatedly referred to in our pages. Dr. Bell's widely noticed article in our June issue pointed out that even now the conditions are beginning to show an unfavorable reflection in the American manufacturing trades. Mr. Stratton's hopeful suggestions have therefore a double interest, in that they bear upon a great subject and are based upon an intimate knowledge and trained observation of actual conditions.—The Editors.

THE manager of a New England machine shop employing six hundred hands recently had occasion to engage a new foreman for one department, and he went outside and got his man. The reason given was that among the one hundred and twenty men in that department he was not able to select one who had the all-round knowledge required to handle the shop.

The tendency of manufacturers to combine and expand their factories into great plants has resulted in a specializing of mechanical work, which is far from conducive to any growth in manual skill or technical knowledge in the worker. Men start, in such shops, upon a certain machine or operation and, more or less speedily, become skillful at that particular work, with a result which can hardly be considered fortunate for themselves. They seldom or never get transferred to another operation as long as their work is satisfactory. They learn absolutely nothing but that one thing, and the steadier a man is—the more skillful and dextrous he becomes—the more surely is he doomed to a continual service in that one narrow rut.

A man in the shop mentioned above recently said to me: "I've drilled just so many holes in just that one part for four years, and I've never yet even seen the machine that part goes into!"

In a Massachusetts factory, where nearly two thousand machine-tool operatives are employed, not over three hundred have received general shop training. The others are young men who have learned no trade, but who can, and do, quickly become deft enough to feed material to some one machine, and feed it fast. The foreman of a gang of forty punch-press operatives, in this factory, lately said:

"There's not a man on the floor, as far as I know, who could carry the work along for a week if I got sick. Not one ever has a chance to show whether he has any executive ability or not. Every man has got to stick to his press and *pay no attention to anything else.*" In such shops the men are not expected, or even permitted, to acquaint themselves with their machines sufficiently to enable them to make repairs or adjustments. If anything goes wrong a man is sent in from the repair shop and the operator is laid off until his machine is again in working order.

Can the workman be blamed for this non-adaptability—this unpreparedness for exigency? "Pay no attention to anything else!" is the absolute root of the discipline in all highly organized shops. The man must visit no other department; he must visit no other machine in his own department. He must not "tinker round" with some idea of improving his own machine. He must produce, "from whistle to whistle," and think of nothing else—or at least do nothing else.

Nor are the managers to blame. They are engaged to manufacture goods at a profit. The educational development of workmen can by no means be entered on the annual report as an asset. Every machine must earn a dividend, and the man behind the machine who keeps its production up to the highest figure is the man who, although sure of a steady job, is just as sure of an inexorable detention at that one job.

There are two openings for men who have the character and determination to lift themselves from the ranks of "machine operators." The first is the apprentice course which, necessarily, is open only to very young men, or boys. Its recruits are largely determined by the opinions of the parents—which are, at the present time undoubtedly pessimistic. "What's the use"—is the consensus of expression—"of a young man's spending years to learn a trade—to become an all-round mechanic—when there are no jobs for such men? When a man can be taken off the street and put onto a lathe or planer, or one operation, and in two months earn as much money, piece work, as the fellow who has spent five or seven years at learning the trade?"

I want to emphasize that paragraph.

In a long experience with old mechanics I can unhesitatingly say that this is the very general feeling among them—that their boys stand no better chance, after a thorough, all-round machine-tool and bench experience, than after a three or six months' steady run on a jig-fitted multiple drill, or similar automatic tool.

That this view is incorrect and narrow there can be no question;

yet the men who express it and who really control the possible supply of future high-grade mechanics can hardly be blamed for their point of view. Nor are they usually in such positions, financially, as to be expected to sacrifice any portion of their incomes, or their sons' possible incomes, in the acquirement of an education which they doubt will be financially beneficial. The percentage of high-grade mechanics, in any highly organized machine shop, is very small compared to the "scrubs." The fathers see that. They form their opinions accordingly and sneer at the probability of any good chances for the first-class machinist.

Managers of thoroughly modern shops understand this feeling and, in most cases I think, appreciate it. They know, moreover, as the fathers cannot know, that there is a real, growing, and insistent need for the skillful, painstaking, old-time mechanic, whose prototype, as has been happily said, "was the foundation of our mechanical supremacy, but who is practically disappearing under the modern system." And to meet this need there has sprung up, during the past few years, a system of apprenticeship designed and fostered by the managers of great machine plants, so radically different from the old system as to well deserve a brief mention in this article.

Perhaps a description of the plan adopted (or rather devised) by the General Electric Company will demonstrate as clearly as any other system what is being attempted and accomplished in this new line.

Boys of from sixteen to eighteen years of age are received on this course, under a four years' agreement, receiving a nominal rate of pay at the start, with a stated, yearly increase, and also a yearly bonus for steadiness and efficiency. At the commencement they are placed in a shop which has been fitted up specially for apprentices, and they are under the control of a man who has been selected for his fitness as an instructor and discriminative disciplinarian. Here the young men get their first acquaintance with machine and bench tools. They work on regular production in simple lines—on turning small shafts and pulleys, and the accompanying boring, tapping, and fitting. Although this first step in handling apprentices has been in use for but three or four years the success of the plan has been most gratifying.

Instead of the old way of turning a green boy immediately into the shops—an unmitigated nuisance to a busy foreman and the butt of jocular misinformation from the men—the lad is first made familiar with shop tools, shop discipline, and to some extent with the system of shop orders and supply methods.

In from six to twelve months, according to his application and progress, he is transferred to one of the regular department shops and, although he is here directly under control of the department foreman, the apprentice foreman always has an eye upon him and he is really looked upon by the embryo workman as still his adviser and instructor. Transfers from one department to another occur after this as the developing intelligence and deftness of the man warrant. At the expiration of the course he has had ample opportunity to become familiar with every type of machine tool in the works, and his practice at the bench has been thorough. He has laid the foundation of skillful and comprehensive handicraft, and he can now make his choice of any one of the various departments, entering as a qualified and valued workman.

Systems similar to this have been, or are now being, introduced into most of the great manufacturing plants; but although the results are excellent to those who are able to take advantage of them, there remain a very great number of young men who have passed the age at which apprentices are taken on—men who have, as before mentioned, learned no trade, but who have worked on some one operation and know nothing else. If such a man is in a city where evening classes and manual-training schools are available he can improve himself as a workman; but something more is required to qualify him as a foreman, an engineer, or as a draughtsman who understands, as all draughtsmen should (but very many do not), the principles of the apparatus he is laying out. To a man who has these higher aims—who has the ambition and determination to lift himself above the condition of a mechanical drudge—the technical correspondence schools offer a rescue. They are easily available to men in any locality, no matter how remote, who would otherwise be unable to acquire the knowledge and receive the training they desire. They afford an opportunity of pursuing a course of study in a methodical and intelligent manner, and are especially helpful to those who would be unable to keep up with a class whose members have had better preparatory training than themselves. They are adapted to the needs of the workingman in that they assume no preliminary education on the part of the student. They employ experts in the line in which courses are to be given, who prepare complete courses of study, from arithmetic up to the most advanced subjects. Only such classes of mathematics are employed as are needed to utilize effectively the formulas and processes employed in actual work, it being deemed necessary to simplify the course in this respect in order to meet the requirements of men who have only an hour or two a day for study.

Many men who are eminently qualified to judge of educational methods are unstinted in their praise of the "correspondence system."

The late Professor Harper of the University of Chicago has said:

> "It is a safe statement to make that the work done by correspondence is equal to the work done in class, and I may go even further and say that there is a larger proportion of high grade work done by correspondence than in the class-rooms. People take work by correspondence only because they wish to get something out of it, while many students come to class merely because they have to—because that particular course is required for a degree."

Dr. C. A. Murray, professor of pedagogy in the same university, is even more emphatic. He says:

> "Those who took a course by correspondence did three times as effective work and gained three times as much satisfaction for themselves as those who took it in the class-room."

Professor C. P. Steinmetz, president of the American Institute of Electrical Engineers, has expressed the following opinion:

> "What the man has seen, practically, in the work-shop, he will take up theoretically in the course, understand it, learn to calculate and control, and afterward, going back once more to the workshop, apply it. Here is where the average college graduate is inferior to the practical man and, in spite of his handicap regarding theoretical knowledge, the latter frequently rushes ahead of the college graduate by his superior understanding of the phenomena, based on his familiarity with them."

The subject of technical education for the workman has become a momentous question to the employer. Managers of great industrial enterprises are finding that the specializing conditions above mentioned are producing machine drudges only. Year by year and month by month it is becoming more difficult to secure men capable of assuming charge of shops—of attending to outside installations of machinery, or repairs on outside plants.

A railroad master mechanic recently remarked that, if he could, he would have every man in his employ take a correspondence course along the lines of his work. The vice-president of one of the great trunk lines has bought a number of courses for subordinates in the civil-engineering department of his road. A former president of the National Association of the Officials of Electric Light Companies states that the man in whose judgment in mechanical matters of greatest importance he puts most reliance, obtained his entire education in the practical work of the shop, with a correspondence course in electrical engineering to complete it. Mr. E. E. Boyer, chief of the assembling and testing department of the General Electric Company's Lynn Plant (ten thousand hands), says that young men who have completed a correspondence technical course have been uniformly successful with him—that he has never known one of them to fall down. This finding of Mr. Boyer's is especially valuable when it is understood that from his department the company largely fills its ever-increasing demand for engineers, installation and repair experts, and salesmen.

The reason for this high commendation is not hard to find. Of all systems of education perhaps there is no other which so surely weeds out the weak and develops the strong. The qualities which go to make a man must be there to commence with. It is no light matter for a young man who has worked ten hours at machine or bench, to shut himself in his room every evening and study hard for two or three hours—usually alone, and without the incentive of competitive class work. Such work requires character—determination, self-denial, temperance, and a large capacity for steady application. If these qualities are present they will be greatly developed; if they are not present the man will drop out. In no human endeavor does the "survival of the fittest" more persistently and certainly occur.

A large proportion do abandon these courses, after having made a spasmodic start. Those who stay and finish have something even greater than their technical education. They have force, patience, self-control and splendid self-reliance. These qualities, backed by the theoretical knowledge of their work acquired on the course, and supplemented by their practical knowledge of shop discipline and practice, make men from whose ranks must inevitably come many of the great engineers and industrial managers whom the future will demand.

EDITORIAL COMMENT

In one point, at least, the military superintendence of the Panama Canal construction is fulfilling our expectations and predictions. This is that the work has disappeared from the public eye. Whether it is going ill or well, it is at all events going silently. The storm of publicity which centered about the Isthmus some months ago has subsided into a great calm, stirred at rare intervals only by the slightest whisper of some brief message—so many yards excavated last month; such an one (civilian engineer) resigned.

Quiet and efficiency are often associated. In the interest of the Nation, may it prove to be so here!

* * *

Attention may profitably be given to the code of engineering ethics which we reproduce on page 799 of this issue. While prepared by a committee of the American Institute of Electrical Engineers only for recommendation to that body, it was designedly framed to express the general principles of professional conduct, and therefore (as noted in our review) in almost all points applies equally to all branches of the engineering profession. It is inspiring to see these ideals so well conceived and expressed, and regrettable that formal difficulties or obstacles prevented the Institute from adopting the code. We are disposed to agree with some lay commentators in the feeling that it would be better even to amend a constitution than to allow it to stand in the way of the final adoption of formulated standards such as most of those this committee has framed.

A code need not be written, of course; it is, indeed, chiefly a compilation and restatement of principles already acknowledged and established. Their force lies in the inherent morality, not the mere legislative adoption. Nevertheless, ideas reduced to expression are far more influential upon many minds than ideas left in the abstract. Many and rigid rules are neither necessary nor desirable; they tend to loss of vitality and stagnation. Indeed, there is danger that strictly professional tenets may be confused with ethical principles and so crystallized in codification that they will actually hamper free development; and there is, on the other hand, danger that through inadequacy of substance or expression, great truths will be but partially stated, thus leaving room for some to err or offend in spirit while keeping within the letter of the code. The proposed system may not be wholly free from one or other of these objections—but this is a matter of detail and of adjustment. The public recognition of a high system of ethics is in every way helpful. An instance and a precedent may be found in the Hippocratic oath taken by every initiate into the practice of medicine. Is there any doubt that the profession is the better, the cleaner, and the more beneficent to the world through the express adhesion of its members to this formula?

In these days of low industrial morality and dubious business methods, especially, it is well to assert and reassert that the professions are under a higher law and must conform to higher standards. Duty to the interests of the client should be held constantly before the professional man as the great obligation which his profession imposes upon him—yet, great as it is, sometimes subordinate to his duty to the profession itself. When this conflict occurs—when, so to speak, the client seeks the commission of malpractice—the engineer must withdraw. Not the least significant part of the code is its indication of the circumstances amid which this action will be demanded. It is well for the laity, as well as for the profession, to be clearly advised of the possibilities of such a situation arising, and of the course which it will certainly necessitate.

* * *

THROUGHOUT the East, certainly, if not more widely over the country, there is very general complaint on the part of railway superintendents and maintenance-of-way engineers that good section hands are almost a thing of the past. Men cannot be secured to work under the old methods, and rapid change is in progress toward a system of track repair and maintenance by large gangs, moved from place to place on a work train upon which they eat and sleep. One would suppose that the conditions of life would be pleasanter for a section man living in his own home, near to his job, free to spend the hours of rest with his family; yet the section gangs, formerly recruited from a class living thus, cannot be kept full, and the herded Italians of the work train are installed as substitute.

To the sociologist this might present a curious phenomenon—not altogether encouraging — analogous, perhaps, to others appearing in certain cases of centralization of population and of industry. From the track point of view it is very unfortunate. Not only the system of minute inspection and continuous repair, but the spirit of emulation between various sections, will die out with the disappearance of the former working units and of the sense of individual identification with definite parts of the work. And, as in many departments of the mechanical trades, the loss of the older training means the loss of the kind of men who made the new order possible. It is said to be already very difficult, and increasingly hard, to find competent men for section foremen. All these things have a direct bearing on the much mooted question of safety in railway travel.

A WRITER in a British daily recently, criticizing the methods of the Rand mining companies, gives utterance to some sound remarks on the tendencies of elaborate systems to become rigid and out of touch with changing circumstances. Although intended for the specific case of the South African mines, the following passage provides an eloquent warning which might be heeded by all industrial concerns in which a central administration is entrusted with the direction of a complicated and widespread business:

> "A vast organization imposes a heavy burden on those who direct it from the centre, and the temptation is always present to relieve the strain by clinging to rules too rigid for the facts, or obsolete because the facts have changed. The only safeguard against the tendency of a great system to stiffen and become muscle-bound is periodic revision by able and independent minds not previously identified with its organizations. Constitutional Government to some extent supplies this need by placing the great offices in charge of laymen and by changing them from time to time. It provides relays of new brooms. Even so, a Civil Service Commission is required from time to time to review and refresh the whole organization. The presence of these two influences accounts in great measure for the difference between an English and Russian Civil Service. Now that business and industry are being organized in larger units every year, the world is beginning to realize that great industrial organizations may outgrow their hides, no less than Government Departments."

Notwithstanding the considerable attention that has been given of late years to problems of organization, it is to be feared that many persons have not yet realized that reorganization is not a finite operation at all, but a continued process. Few businesses work under the same set of circumstances from decade to decade, and it cannot be too clearly understood that the best of systems becomes actually harmfu when it no longer corresponds to the conditions of the moment. In other words, the internal life of a large business is just like the internal life of any other organism. It grows and decays, and even when it is doing neither of these it is constantly undergoing change in its external relations. What has come to be termed "reorganization" is therefore a book of which we can never come to the last page, and this is so even without taking into account the constant improvements in methods of organization, which is perhaps as progressive a branch of knowledge as the technical side of manufacture. There is the less excuse for allowing an organization to become obsolete, in that, commonly, no capital to speak of is locked up by the adoption of any particular method. Unlike heavy machinery or particular systems of transmitting power, the materials and appliances for any reasonable system of organization are comparatively inexpensive, and bear very small relation to the great economies which may be effected from time to time by making the system correspond more closely to the actual working conditions. The principal danger of elaborate systems is that they make the work of subsequent modification more difficult than it should be.

* * *

The President's very far-reaching proposition concerning the extension of employers' liability, and the "automatic" process for the recovery of damages by injured workmen, seems to have received less comment than might have been expected in the industrial press. Possibly the reason lies in the general acceptance of the belief that any legislation directed to such results must be State rather than Federal, and that even the most energetic utterance from the Chief Executive of the Nation therefore is but a suggestion. Nevertheless, it is certain that the movement of the future will be in the direction pointed out by Mr. Roosevelt, if not at the rate nor to the distance he indicates. The tendency of judicial decisions, the drift of public opinion, and the experience of the older countries all afford strong evidence of this.

Our present waste of life and limb, in constructive work, mining, manufacturing, and transportation, is appalling. When all allowances have been made for the recklessness of employees, there remains a heavy charge against us as a nation of employers. We seem still to hold, perhaps unconsciously, some of that low estimate of the value of life which belongs to new countries. In the haste to do, and to do quickly and cheaply what has to be done, we give too little thought to safety and are too little impressed by accident, especially as the penalty is generally paid by someone else. Severe liability laws are designed to bring back that penalty to the interest responsible for the entire control of both undertaking and methods.

In fact, they do better than this. The risk placed upon employers is at once shifted to insurers. Here as elsewhere, these are rising and will increasingly rise to the demands of the situation and in large measure control the conditions they are called upon to insure. Fire and marine risks have been immensely improved by the careful study, regulation, and inspection established by the underwriters. Accident risks will follow the same course. Not only will the inevitable proportion of loss be distributed over industry at large, but this proportion will be reduced to a minimum through the watchfulness and oversight of the liability companies. We shall save hands, limbs, and lives instead of paying for them, and that which was designed as a remedy will become, to the largest possible extent, a preventive.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

STANDARDIZATION AND LABOR EFFICIENCY IN RAILROAD SHOPS

THE METHOD OF EXACT MEASUREMENT APPLIED TO INDIVIDUAL AND SHOP EFFICIENCY AT THE TOPEKA SHOPS OF THE SANTA FE.

Harrington Emerson—American Engineer and Railroad Journal.

THE Santa Fe has taken a leading place in the application of standardization and systematization to the efficient and economical management of railway shops, on the principles laid down in Mr. H. W. Jacobs' notable series of articles in recent numbers of THE ENGINEERING MAGAZINE. Economy and efficiency of labor have been studied in great detail and the remarkable results obtained at the Topeka shops form the subject of an interesting paper by Mr. Harrington Emerson in a recent number of the *American Engineer and Railroad Journal.* The paper is interesting also in offering a concrete example of the benefits to be derived from standardization, as described in an article on the economical utilization of labor reviewed in these columns last month. Mr. Emerson's article gives many tables and examples which it is impossible to reproduce, the following extracts giving only an outline of the methods employed and the results obtained.

"Shop efficiency pays. By shop efficiency is meant a careful investigation and betterment of all conditions, so that with the same effort men can accomplish more. To secure the co-operation of the worker with the management in cutting out unnecessary wastes at the Topeka shops of the Atchison, Topeka & Santa Fe Railway, he is offered an increase of as much as 20 per cent. If by means of special strength or skill he does more work than normal he is given *all* the gain, for instance, if he does in one hour a job standardized at two hours he receives two hours' pay for an hour's time. The management gains, firstly, by the elimination of unnecessary wastes, although it gives the worker a 20 per cent. increase, and it particularly gains by the increased efficiency of its machines and other equipment, which results in a larger output without the necessity of increasing the capital investment. The actual results at the end of two years of systematically organizing the Topeka shops on an *efficiency* basis were:

To increase the average pay of the men	14.5%
To decrease the unit cost of production	36.3%
To increase the shop output	57%

"There is no reason why all the men should not earn at least a 25 per cent. increase above standard wages, and many of them do, 40 per cent. of them earning a 25 per cent. increase and better. The average efficiency of all the men in the month of April, 1907, was 94.2 per cent. Two years ago it was about 60 per cent. Although the average of all the workers is 94.2 per cent. there are many who are better, many who are not as good. One man earned 105.4 per cent. above standard wages. Four men drawing full pay were 64.7 per cent. below normal, doing only one-third of what they should have done. These figures are not guessed at, but taken from the actual operations of this large locomotive repair shop in which every job is standardized and the efficiency of every man determined. Now, the system is perfected and it costs no more to keep it in operation than the former barren methods. The successive steps of progress were:

1. A permanent and standard *method* for determining costs of every operation.
2. The betterment of all conditions.
3. The determination of a standard cost of *every* operation.
4. A comparison of actual costs with standard costs as to every operation.
5. The guarantee to each individual worker of standard wages, and the payment of an added amount based not on the piece or on output, but on efficiency.
6. A check and reward of each foreman on the basis of the efficiency of those under him.
7. A check of the efficiency of the shop as a whole from month to month.
8. The use in all accounting, of *standard costs,* not *accidental* actual costs.

A brief outline of the successive steps follows:

"Costs are of two kinds, those that can be located and those that cannot be located. The work of a machinist and also of his machine can be located. The problem of cost determination reduces itself into apportioning to each man and each machine, the indirect or unlocated costs in addition to the direct or located costs. To do this, each item of indirect cost is apportioned either to men or to machines or partly to one and partly to the other. Having thus secured two grand totals, one of indirect men costs and the other of machine costs, the totals are subdivided to various departments. Whereas the indirect cost as a whole may be 75 per cent. of the pay roll, within the confines of a department, the percentage may vary from 15 per cent. up to 400 per cent., showing how absolutely inaccurate the usual method is of applying the same flat rate of factor, surcharge or burden to all departments alike.

"Having secured substantial accuracy by apportioning each class of costs, men-costs and machine-costs, to each department, no great errors can arise in any particular method of subdividing departmental charges to specific men and machines. The simplest method is therefore preferable. The method adopted at Topeka was to assess indirect men-costs as a percentage on applied labor, to assess all direct and indirect machine costs as a yearly charge on the inventory value of the machines. To ascertain the hourly rate for each machine, the yearly charge to the machine was divided by 2,400 hours, it being assumed that the machine worked 80 per cent. of the time. If there were any gains in simplicity to be effected by modifying this general method within the boundaries of a department there was no hesitation in allowing common sense to govern. For instance, when it was discovered that a direct worker on a shear did 200 different small jobs a day, he was at once considered an indirect worker, and when a machine rate worked out at $0.01 an hour, the machine was promptly relegated to the list of indirect machines. There is no sense in an accuracy that makes the distribution of cost amount to more than the cost itself.

"Power is determined at so much per horse power and floor space at so much per square foot for the plant as a whole and charged on a flat basis to each department. If one department is further from the power house than another and therefore suffers a greater line drop loss, this loss is considered a plant loss, not a department loss, and it is borne in the form of a general increase in power cost. What would one think of a gas or water company which charged more for gas or water because the customer was farther from the central plant or which charged repairs of mains to the customers served by the mains, yet just this kind of cost accounting has brought the whole art of factory cost accounting into deserved disrepute!

"With a machine rate, man rate, and man surcharge provided, and time known, the cost of every operation is at once determinable. . . . . .

"The betterment of all conditions was a very large task and involved everything that could be done to improve machines, tools, operation and general comfort of the men, as, for instance, better lighting and heating. It is evident that standard costs could not be determined until conditions were in the main standardized.

"The determination of standard costs was most completely and conscientiously carried out. The motto adopted and promulgated by the authorities in a pamphlet distributed to the men was:

'Fairness, not Favoritism.
Individuality, not Subserviency.
Efficiency, not Drudgery.'

"A time study of a job under actual working conditions by the regular worker was made by a practical man, a machinist, a boiler maker, or a blacksmith, as the case might be. The machines and other conditions, tools, belting, speed, etc., were first adjusted. It made no difference whether the job under observation actually took a long or a short time. It was the duty of the observer to set down a reasonable and proper time. As a rule the times eliminated from standard were not those of reasonable work, but those of unnecessary waste.

"The comparison of actual costs with standard costs as to every operation is exceedingly easy. Each job is assigned to each man on a work card which states the standard time. The man notes his own actual time which in the aggregate must check with his clock time. The efficiency of each man is tabulated each month and the efficiency reward is on a sliding scale. It begins at 67 per cent. and increases rapidly according to a table carried out to tenths of a per cent.

"The efficiency of the foreman depends on the efficiency of all the men under him. If all the men average 100 per cent. the foreman receives 20 per cent. increase on his own wages. Under some other foreman the extra earnings of the men might be in the aggregate more, but not average as well, if some men were very good and others very poor. Such a foreman would earn less increase, so it is to the advantage of a foreman to bring up his whole force evenly."

Mr. Emerson shows two diagrams of monthly records of shop efficiency, the abscissæ of the points on the curves representing percentages of efficiency, and the ordinates, percentages of time worked at the efficiencies shown. On these a vertical line shows the average efficiency for the month. Commenting on these records Mr. Emerson says:

"Shop efficiency as a whole is determined by the average efficiency of all the workers. The two diagrams show the same shop in two successive months and the improvement in the second month is largely due to the lessons in the diagram of the first month. It is plain that the shop is improving when the average efficiency line moves to the right, that it is retrograding when it moves to the left. It can be made to move to the right by finding out what the matter is with the men whose average efficiency is low, and all workers with an efficiency under 70 per cent. should be investigated. The record is there not only as to monthly efficiency, as a whole, but as to every single job done in the month. It often happens that efficiency falls through no fault of the worker, as when a steel casting is so hard as to make normal work impossible. In very marked cases of this kind temporary schedules are put into effect to suit the peculiar and exceptional occurrence.

"Since every job is standardized it necessarily has a standard cost. How ridiculous it would be for a railroad company to attempt to vary its ticket prices on account of accidental delays or extraordinary expenses, as for a wreck.

"It is not less ridiculous to attempt to follow into costs accidental variations of shop operation. If a fast worker is on a job one day and a slow worker on the same job the next day, both have varied from standard, but the selling price of what they have made has not changed.

"Variations from standard costs are accidents of shop operation and are to be taken care of, not in detail but as a whole, by a factor added in the office. In the examples of the two months, the efficiency of labor was 89.5 in March. Actual labor costs were therefore 11.7 per cent. higher than standard. This 11.7 per cent. could have been applied to each item of the output in the following month. In April the actual costs were 6.2 above standard, so for May 6.2 per cent. could have been added to the direct labor part. The discrepancies should, however, be averaged for at least twelve months, and if this was done it would be found that the fluctuation in office factor to be thrown forward with the succeeding month would not vary as much as 1 per cent. from month to month.

"The effects of this system of shop management are:

(1) To increase output enormously without adding to shop equipment or space.

(2) To reduce unit costs as much as 30 per cent. or more.

(3) To increase the pay of the best men as much as 30 per cent. on the average.

(4) To hold permanently the best men.

(5) To know accurately the cost of every item before work is begun on it.

"The system is equally applicable to railroad operations as a whole, *i. e.*, the mileage of engines and cars and tonnage movement. It is, in fact, on the Santa Fe now being adapted to determine the efficiency of each engine, exactly as in the Topeka shop it has been perfected to determine the efficiency of each man. Even as men in average shops work with less than 60 per cent. efficiency, so also do engines work with less than the 60 per cent. efficiency. What was done with the men in the shop can be done with engines."

A RAILROAD APPRENTICESHIP SYSTEM.

AN OUTLINE OF THE APPRENTICESHIP SYSTEM RECENTLY INTRODUCED ON THE NEW YORK CENTRAL LINES.

C. W. Cross and W. B. Russell—Railway Master Mechanics' Association.

THE scarcity of skilled workmen, which has led to the recent revival on an extensive scale of the apprenticeship system, is nowhere a more serious problem than in the motive power departments of the railroads. The recent inauguration of an apprenticeship system on a large scale in the shops of the New York Central Railroad is important, not only as an example of what may be done in manufacturing and commercial organizations, but as indicating a development in railroad management which promises to be far-reaching in its results. The following outline of the New York Central system is taken from a paper by C. W. Cross and W. B. Russell which was one of the most interesting presented at the recent annual convention of the American Railway Master Mechanics' Association.

"The purpose of the apprentice system is to provide the Motive Power Department with an adequate recruiting system which will eventually produce from the ranks a large number of skilled workmen, a number of foremen, a sufficient number of good draftsmen, a few Master Mechanics and an occasional Superintendent of Motive Power. The general plan is twofold, and provides for shop instruction of the apprentice in the trades and also for his instruction in mechanical drawing, practical mathematics and shop problems during working hours while under pay.

"A Department Headquarters was first organized to outline the courses of instruction and to prepare the necessary instruction sheets and text-books. Two instructors—a shop instructor and a drawing instructor—were then appointed at each of the larger shops; a uniform set of apprentice regulations was adopted for all shops and a schedule provided showing the time allotted in the shop to each class of work. This schedule is sufficiently flexible to insure a prompt movement of the apprentices from one type of work to another and still to leave opportunity for rapid movement in case of special merit. Both the shop instructors and the drawing instructors are under the local shop officers and responsible directly to them. Regular reports are made by both instructors to their immediate superiors, who forward them to the apprentice headquarters. In the educational work, however, the instructors are kept in direct touch with the Apprentice Department.

"The plan is now in operation at nine of the largest shops of the system, and includes about 450 apprentices. The work is gradually being extended to the smaller shops. The drawing instructor in every instance is a draftsman or mechanical engineer, located either at the shop or a company drafting room close at hand. The shop instructor in most instances holds some other position in the shop in addition to that of apprentice instructor. The apprentices are under the foreman, and responsible to him as formerly, but the foreman is relieved of the duty of instructing them, thus enabling him to give his full time to directing the work of his department.

"The work in drawing and shop problems is outlined at the apprenticeship headquarters at New York city, and sufficient flexibility is allowed to fit the personality of the local instructor and the needs of the local apprentices. The plan of instruction is arranged to give the closest possible connection between the work in the shop and the work in the classroom. Subjects are not classified as in most school systems, but the necessary mathematics, mechanics, physics, and chemistry are introduced only as needed to solve some practical shop problem. The drawing is from actual parts from the start, omitting all exercises and geometrical work as such, and introducing principles only as needed to gain practical ends. Simple blue-print sketches are used for the drawings in connection with the actual machine parts; printed sheets are supplied for the problems. The shop instructors co-operate with the drawing instructors in looking after the general welfare of the boys. Arrangements are made for the instructors to make occasional visits to other shops to observe methods of instruction. Apprentices are sent to visit other shops and report their observations.

"The instruction is largely individual, with classes limited to twenty-four apprentices at one time. By use of the blueprint sketches on which are the necessary directions, it is possible for the instructor to hand an apprentice a sketch and a machine part, thus enabling the apprentice to start at once on the work. This method permits the instructor to keep a class of twenty-four busy, even when each member is working on a different sheet. The first drawings are very simple, so that accuracy may be insisted upon from the start. In order to save time and have corrections made at once, no work is removed from the drawing-board until it receives the instructor's O. K. The work is scaled so that it can not be copied from the sketch and the course is arranged to advance more slowly than usual drawing courses. One principle is introduced at a time, and then only as needed to make an actual car or locomotive drawing. Lettering is an incidental item. The shop problems are usually worked at home on standard sheets, and an occasional blackboard review is given in class. The home work is assigned on loose printed sheets which makes it possible for an apprentice to go as rapidly as he desires. In the courses that are now used, much that is dear to the mathematician and physicist has been left out. All the work that is introduced is in accordance with the New York Central Lines practice, from which illustrations are selected. A comprehensive system of reports is made by both instructors to the local shop officers. These reports show: First, the ability at the trade; second, the disposition and personality of the apprentice, and, third, the standing in class work. The instructors are at all times required to know the standing of each apprentice, thus making examinations unnecessary. Special emphasis is placed on the personal touch maintained between the instructor and the apprentice, with a view to determining the type of work or branch of service for which the boy is best fitted. It has been found necessary to use great care in selecting instructors, who must be men who are not only competent, but who are willing to undertake the work for the love of it and their interest in the young men, as well as for the remuneration they receive. At the expiration of apprenticeship, those who have satisfactorily completed their term receive certificates which entitle them to preference in employment at all shops on the New York Central Lines.

"Instruction is given each apprentice four hours a week during shop time; that is, two mornings from 7 to 9 o'clock, and such instruction is all classed under the name of mechanical drawing. Apprentices ring in before coming to class and are under shop discipline during the session. At 9 o'clock they proceed directly to the shop. Home work is expected on the problems. Both instructors are available for consultation during the noon hour.

"No more interesting study has presented itself than the personality of the average apprentice. On the whole he is below the standard of education and ambition generally presumed by most motive power officers, who naturally think all apprentices possess the same exceptional initiative and earnest endeavor which has brought them up from the ranks. The average apprentice possesses a great deal of human nature; he means well, intends to make the most of his opportunity, generally prefers to be a real boy and to enjoy life, rather than to work problems at home; he will not read a text-book except under compulsion, and has absorbed a little of the idea that the easiest way to become a journeyman is to do as little work as possible. On the whole, however, the interest of the apprentice is good, and is increasing in proportion as the facilities for experimental work are increased and the plan of instruction is extended. There are instances where the boys have kept the local instructors busy in supplying them with work, and it is evident that the ambition of many boys has been aroused and that the right chord has been struck, so that in time the boy without ambition will become a rare article. Reports show that apprentices started during the last year have evidenced a most commendable enthusiasm. It might also be interesting to state that at nearly all points there are advanced apprentices who take full charge of classes when the instructors are absent.

"The effect upon the apprentices has already awakened interest and marked improvement in skill in the shop, ability to read drawings, ability to lay out templates, and in several cases skill in drafting sufficient to warrant assignment to the drafting room for sixty-day intervals.

"Perhaps as vital as any other principle is the necessity for caring for graduates with infinite pains after they have completed their apprenticeship terms. The results of the best possible apprentice system may be absolutely nullified if the organization into which the graduates are to go is not properly prepared to receive them. It is not too much to say that most railroads and most industrial establishments need to put their organization in such order as will render not only employment desirable, but advancement possible. As an incentive to all and a reward to the especailly studious and proficient, it is desirable to give a limited number of those showing the best records a prize in the way of a more advanced course at a technical school at the expense of the railroad, the young man to work in the shops during vacation time, thus retaining his close relationship to the work.

"It will undoubtedly take years to show the full value of the apprentice system. Already draftsmen are being provided for the Company drafting rooms, and New York Central standards are becoming familiar to all apprentices. In the future every journeyman will be able to read drawings and make working sketches. Men will show greater pride in their local shop and increased loyalty to the Company, and the tendency to resign their positions for work with other companies will be lessened. It is not expected that all of the boys will attain a degree of efficiency that will qualify them for leadership, or that all workmen will possess the same measure of ability and activity, on account of the difference in their natural intellectual and physical qualifications, but it is expected that each will be developed to a high degree in his particular line, with the result that eventually each shop will be manned by a force of mechanics embodying an advanced state of proficiency from which at least a few competent men may be had at all times for positions of leadership."

GAS PRODUCERS FOR PULVERIZED FUEL.

A DESCRIPTION OF A GAS PRODUCER RECENTLY DEVELOPED IN FRANCE WHICH UTILIZES ALL GRADES AND KINDS OF COAL WITH EQUAL FACILITY.

Le Génie Civil.

ACCORDING to a recent number of *Le Génie Civil* the problem of utilizing all grades of coal in the gas producer has been satisfactorily solved in France by the invention of M. Marconnet of a producer into which the fuel is introduced in a finely divided condition. The following abstract gives a description of the producer and the advantages claimed for it.

M. Marconnet has succeeded in developing a gas producer which utilizes with equal facility fuels entirely free from volatile constituents, such as coke dust, and fuels in which the proportion of volatile matter reaches as high as 30 to 35 per cent.

Further, the percentage of ash is a matter of indifference, the producer working equally well with fuels containing 5 or 30 per cent. of incombustible matter, and good results have been obtained with even bituminous shales containing 70 per cent. of ash. Finally, not the least important advantage possessed by this producer is the fact that it is able to utilize the fine coal and slack which ordinarily goes to waste in coal-mining and washing operations. These results are attained by charging the producer continuously with pulverized fuel, thus avoiding all the difficulties encountered in the ordinary type of producer with its intermittent charging of lump coal.

The use of pulverized fuel makes grinding necessary. This is done usually in tube mills, the cost under ordinary conditions being from 1¾ to 2 francs per ton. The fuel is introduced into the producer by means of an apparatus which resembles in principle the carbureter of a gasolene motor: that is, the air drawn into the producer carries with it the pulverized fuel with which it becomes thoroughly mixed before it enters the producer proper.

The producer proper is cylindrical in form and is lined with some sort of refractory material. The mixture of air and coal dust enters at the bottom of the cylinder and tangentially to its circumference. Combustion is set up in the first place by the introduction into the producer of a few pieces of burning wood, the admission of air and fuel being cut down to convenient proportions. The temperature rises rapidly and full working conditions are attained in a very short time. The incombustible materials are projected by centrifugal force to the walls of the producer where they collect in small liquid globules and finally run down into a slag at the bottom. This slag is tapped off every six or eight hours through a tap hole similar to that of a cupola, an arrangement which gives every satisfaction. This slag varies in appearance with different kinds of coal. It is very rare to find a coal of which the incombustible constituents will not settle in this manner, and such difficulties can generally be removed either in the grinding or in the charging of the fuel.

"To obtain regular working of the apparatus, it is of prime importance that the proportions of air and of coal should be capable of exact regulation and maintenance at all rates of working; in other words, that the charging device should have a simple and efficient regulating mechanism. M. Marconnet has achieved this result in the following manner:

"The pulverized fuel is charged into a hopper whence it falls by gravity on to a horizontal revolving plate placed about one centimetre below the hopper. This plate is revolved by means of a friction roller, working on its under side, the distance of which from the axis of the plate can be regulated during working. During the rotation of the plate the fuel is met by a scraper placed obliquely, which causes the coal to fall in a thin stream on a second plate which may be adjusted at any angle to the horizontal. In sliding off this latter plate, the pulverized fuel passes the intake of a fan which supplies air to the producer and is drawn in along with the air, the mixing process being complete.

"Since the rate of working of the producer varies with the speed of the fan, and the speed of rotation of the feed plate depends directly on the speed at which the fan is driven, the supply of coal varies automatically with the air supply. Further regulation of the fuel supply may be obtained by changing the position of the friction roller, raising or lowering the rotating plate to increase or lessen the flow of coal from the hopper, altering the position of the scraper, or changng the angle of inclination of the adjustable plate. In the latter case, changing the angle of inclination of the plate alters the distance of the falling stream of coal from the intake of the fan. By this means the fineness of the coal supplied to the producer can be regulated as the size of the lump that can be drawn in by the current of air depends upon the distance of the stream of fuel from the fan intake. A receptacle is provided into which the larger particles, unaffected by the air current, fall, whence they are returned to the tube mill for further grinding."

A 600 horse power unit has already been constructed on this system and put in successful operation. This producer occupied a space 1.8 by 3 metres and was 3 metres in height.

The high temperature produced at the moment of combustion and the thorough mixing of the gases by their rotary movement in the producer has the effect of completely breaking up the heavy hydrocarbons into gaseous products of simple chemical composition. After eighteen months of operation with coals containing 30 to 35 per cent. of volatile matter no trace of tarry products has been found. The absence of tar makes the cleaning of the gas an easy matter as it is necessary only to cool it and to remove any dust which may be carried over.

THE UTILITY OF INVENTIONS.

THE MEANING OF UTILITY AS PREDICATED OF INVENTIONS IN THE PATENT LAWS OF THE UNITED STATES.

John E. Brady—Electrical World.

THE relation of patents to the manufacturing industry was very fully treated in Mr. Prindle's series of articles in recent numbers of THE ENGINEERING MAGAZINE. In connection with this series the following extracts from an article by Mr. John E. Brady in a recent number of the *Electrical World* are interesting as showing the extent to which an invention must be of public utility before it is patentable.

"Utility, as predicated of inventions, means industrial value; the capability of being so applied in practical affairs as to prove advantageous in the ordinary pursuits of life, or to add to the enjoyment of mankind. But a mere curiosity, a scientific process exciting wonder, yet not producing physical results, or any frivolous or trifling article or operation not aiding in the progress nor increasing the possessions of the human race, whatever be its novelty, and whatever skill has been evolved in its production does not fall within the class of useful inventions nor become the subject matter of a patent. It has been said that the test whether an invention is useful in the sense of the patent law is not whether it is not mischievous or hurtful, or insignificant, but whether it is capable of use for a purpose from which some advantage can be derived. If it be useful in this sense the degree or extent of its usefulness is altogether immaterial. It is not necessary that it should be the best means of producing a desirable result, but a means, although inferior to others, of producing it.

"Inventions which accomplish definite practical results may nevertheless possess such attributes as destroy the benefits that otherwise they would bestow upon the public. Inventions whose chief or only value resides in the facilities which they afford to men to perpetrate some wrongful injury either by fraud or violence upon each other, are thus regarded as destitute of real utility. For the same reason arts or instruments which, if completed and in actual use, might be of benefit to their employers, are sometimes held to be devoid of real utility on account of the great risks incurred in their construction. The courts, in their consideration of this subject, must necessarily contemplate the entire scope and effect of the invention, as well upon the maker and operator as upon the consumer; and if the net result to the community at large is not a benefit, the inventor has no claim upon the public.

"The acts of Congress which authorize the grant of patents for designs, were plainly intended to give encouragement to the decorative arts. They contemplate not so much utility as appearance. The law manifestly recognizes that giving certain new and original appearances to a manufactured article may enlarge the demand for it, may enhance its salable value, and may be a meritorious service to the public. It, therefore, proposes to secure for a limited time to the producer of those appearances the advantages flowing from them. Utility is not negatived by the fact that the manufacture covered by the patent has no function except to decorate the object to which it is designed to be attached. In such cases utility resides in beauty. Whatever is beautiful is useful, because beauty gives pleasure, and pleasure is a kind of happiness, and happiness is the ultimate object of the use of all things. The

Westinghouse Electric & Manufacturing Company, being the owner of a design patent issued March 22, 1902, to Albert Schmid, brought an action against the Triumph Electric Company, seeking to enjoin the latter from infringing its alleged rights under the patent. The patent involved covered a design for a configuration of a frame for electrical machines. It was held that the word 'useful' in the section regulating the issue of design patents does not require that the shape or configuration of an article, in order to be patentable, shall add some new utility to the article, but is used merely for the purpose of excluding such things as might have a vicious or corrupting tendency, and that a new and original design for an article may be patentable where it merely improves its appearance. But it was further held that, assuming that a frame for an electric machine might be made the subject of a design patent, the frame design in question was not properly patentable for the reason that it was neither new nor original in view of the existing state of the art. The only originality which the counsel for the complainant could reasonably claim for the design patented was found in the curvature of the bases of the pillars for supporting the shaft and of the supports to the cylinder frame for the field; and these were considered differences which would suggest themselves to any workman, and which did not involve the exercise of inventive genius, which is as essential to the validity of a design patent as it is to the validity of a mechanical patent.

"It seems that utility is negatived if the function performed by the invention is injurious to the morals, the health or the good order of society. Thus, an invention to improve the art of forgery, or one to facilitate the spread of a contagious disease, or one to render water or air intoxicating would, of course, be unpatentable for want of utility. The more completely such an invention could perform its function the more objectionable it would be in this respect. In the case of National Automatic Device Company vs. Lloyd, the complainant moved for an injunction restraining the infringement of a patent for a 'Toy Automatic Race Course.' The device covered by the patent consisted of a shaft projecting upward from the center of the base of a circular shell or case, to which shaft a clock-work mechanism was so geared that it could be made to revolve rapidly by releasing the escapement of the clock-work. On the shaft were mounted two or more radial arms, to the ends of which were attached small toy figures of horses. The clock-work was released by dropping a coin through a slot in the machine, whereupon the shaft would revolve, carrying the radial arms with it, for a short time, when the clock-work would be shut off allowing the arms to revolve of their own momentum. The proof showed that the only use to which the device had been put was to install it in saloons and other drinking places, where the frequenters thereof might lay bets as to which toy horse would be the last to stop or would stop nearest a certain designated point; in other words, the machine was used only for gambling purposes. For this reason the machine was held not to be a benefit to society or 'useful' within the contemplation of the patent act and the patent was declared void. It was urged that the machine was susceptible of being utilized as a toy or child's plaything, but the fact that no such use of it had been made was considered a sufficient answer to that contention.

"Inventions the object of which is to afford amusement and diversion, are classed among patentable subjects; but only the mechanical agencies employed can be patented. Under this rule it was held that the patent of the Paul Boynton Company, covering an inclined gravity railroad terminating in a body of water which provided an amusement popularly known as 'Shooting the Chutes,' was invalid, one of the reasons being that, in view of the old art of launching ships, there was no patentable novelty in the combination of an inclined railway located near a body of water and a boat-shaped car or toboggan, adapted to move downward over the railway and to be propelled forwardly upon the water by the momentum derived from its descent.

"In the Cushman case, an electrical patent was refused on the ground of the absence of utility and an appeal was taken from the decision of the Commissioner in so refusing. The device for which a patent was sought consisted of an improved method for protecting objects from the effects of lightning by surrounding that part of the lightning rod which is embedded in the earth with a galvanic battery. Its construction and functions were described by the inventor in the following language: 'To facilitate the discharge of the electricity from the conductor to the earth is the object of my present invention, and it consists in surrounding that part of the lightning rod embedded in the earth with plates of dissimilar metals, arranged in such a manner as to constitute an open galvanic battery. Electromotive power will divide the electricity on the metallic plates and, as they are insulated, they will act as a condenser of the electricity that is opposite to that of the air. Should there be a high electrical tension of the air, by this means the electrical fluid conducted through the rod is more readily discharged by uniting with the opposite electricity as it accumulates on the surface of the plates. When the discharge flows from the earth to the air, then the rod conducts from the plates such electricity as is opposite to that of the air.' The reason which the Commissioner gave for refusing a patent was that the intensity of the action arising from either the copper or the zinc plate, or both, in the earth, is thousands of times too small to be sensible as compared with that of a flash of lightning. 'The latter has force enough to strike through hundreds or thousands of feet, or sometimes through miles of air. The former has not force enough to strike through the thousandth part of an inch. These are well known facts and the thing must be entirely without practical effect.' The court was satisfied that the device in question could be put to no beneficial use and the Commissioner's refusal was affirmed.

"The degree of utility is not material and a patent may rightfully issue, so far as that quality is concerned, provided the invention be of some use and benefit. Nor does the simplicity of a device indicate in any way the absence of utility, for this is a recommendation of the usefulness of the article rather than an objection thereto. The existence of utility in an invention is not to be determined by comparing it with other arts and devices, but is rather to be ascertained by an examination of the particular art or device in question. It is not essential to the patentability of a device that it should supersede or be superior to others previously used for the same purpose; nor does the fact that an invention has been displaced by some subsequent invention import a lack of utility. If, however, a patented article rapidly takes the place of all others of similar kind and is successful commercially, these are considerations tending to show that the public welfare has been advanced by its production and that it is characterized by utility within the meaning of the patent laws."

THE EIGHT-HOUR DAY IN COAL MINES.

A REVIEW OF THE EFFECTS OF THE EIGHT-HOUR DAY ON OUTPUT AND WAGES AS DISCLOSED BY THE REPORT OF THE BRITISH COMMITTEE OF INQUIRY.

Engineering.

THE report of the Committee of Inquiry appointed to investigate the probable effects of the proposed establishment by law of a uniform eight-hour day in English coal mines has been published and is in many respects a valuable and interesting document. The following extracts are taken from an editorial in a recent number of *Engineering* which deals with the findings of the Committee with regard to the effect of an eight-hour day on output and wages, a problem which is of great importance in America also where agitations for the establishment of a legal eight-hour day for miners are by no means unknown.

"The first part of the report deals with the effect of limitation to an eight-hour day upon production. The Committee find that at present the average time spent underground on a day of full working by all persons employed in mines is 9 hours 3 minutes, the time being reckoned from the winding of the first cage of men down the pit to the winding of the first cage of men of that shift up to the surface. (This is the basis adopted by the Committee for the reckoning of an eight-hour day from bank to bank.) To reduce this period of 9 hours 3 minutes to one of 8 hours would reduce the aggregate hours underground, in a week of full working, by 10.27 per cent., assuming the customary short and idle days to remain as at present. On these customary short and idle days there is a loss of time within the eight-hour limit amounting to 6.48 per cent. of the present theoretical full working time. For a maximum eight-hour bank-to-bank day the Committee give the following possible averages:—

1. Six days of 8 hours each . . 48 hours.
2. Five days of 8 hours, *plus* present short day (involving abolition of customary idle days, and also customary short days not falling on Saturday) .... 46 hrs. 13 min.
3. Present arrangement of idle and short days, but all full days reduced to 8 hours .... 44 hrs. 45 min.

"These figures are, of course, not hours of work, but include meal-hours and time taken to go to and from the place of work.

"Now a reduction of such magnitude in the hours of labour as is shown by No. 3 above must necessarily cause a great decrease in the production of coal, but the Committee have endeavoured to find out whether some time that is now lost might not be recovered under the new *régime*. They find no saving of any importance is to be looked for in the customary total stop-days or customary short days of less than eight hours; but they do expect that a material saving can, and will, be made from the time that is at present lost owing to stoppages at the pits and to voluntary absenteeism. We are not prepared to accept completely the reasoning by which the Committee arrive at this latter conclusion, as factors enter into the question to which they do not appear to have given proper weight; but for the moment it may be accepted, as even with such a saving of time for work as is thus made possible the Committee still find that some diminution of production would follow the statutory reduction of hours. Other means of saving time have, therefore, to be looked for, and naturally the Committee try to see if these may be found in improvements in the mechanical equipment of collieries, in the possibility of sinking new shafts and of using ventilation (upcast) shafts for winding, and in the extension of the multiple-shift system. Each of these possible remedies is carefully examined by the Committee, but the conclusions arrived at do not seem to us to be encouraging to the advocates of the rigid eight-hour day. Much of the increased production of coal in recent years is undoubtedly due to the use of mechanical coal-cutters and conveyors; and still further increase is to be looked for from the more general use of these machines; but if a rigid time-limit for working be imposed, the use of such machines will be checked, and probably made much less extensive than it now is; for their method of operation makes it absolutely essential to have an elastic shift for the men attending to them. This has been made quite clear to the Committee, who find that in any limitation of the working day to eight hours the question of exemption for those in attendance on mechanical coal cutters and conveyors must be considered, as a strict observance of a limited day in their case would, in our opinion, greatly interfere with the development of this method of mining. It may be true, as the Committee point out, that the men who are at present actually engaged in this kind of work are few in number; but if production is not to be reduced, mechanical cutting must be greatly increased, involving a large increase in the number of men attending to the machines, so that in time the exempted class must grow to large proportions.

"Managers would undoubtedly, in many cases, like to adopt the multple-shift system, but they are prevented from doing so by what the Committee call the systematic opposition of some of the local trade unions to the institution of a double-shift on what they conceive to be grounds of trade policy. And even if this opposition were withdrawn, where is the labour to be obtained? The ordinary unskilled labourer may be induced to take employment at a colliery as a surfaceman, or even underground, but he cannot be a hewer without serving an apprenticeship, and it is the duplication or multiplication of the class of hewers that is absolutely necessary if the multiple-shift system is to be introduced. Compare, then, the following two conclusions at which the Committee have arrived:—

We are of opinion:—

"That for these collieries the output of which is limited by mechanical conditions —*i. e.,* their capacity for haulage and winding—and which are unable to improve their mechanical equipment, *the double shift would be a necessity.*

"That the principal, and perhaps, at present, insurmountable obstacle to an immediate adoption of the multiple-shift system is *the impossibility of procuring the necessary labour.*"

"From such conclusions it is abundantly clear that even if in the course of time a fresh supply of labour, either home or foreign, could be obtained for the mines, the sudden reduction of the hours of labour can only result in a very considerable reduction of output. The Committee recognise this fact. They find that the extent of the reduction would vary greatly in the different colliery districts, and be most serious in those districts—such as Lancashire and South Wales—in which at present the longest hours are worked. They add that the deficiency would be increased beyond the amount they have calculated unless certain relaxations of a rigid rule were made for certain classes of workers, numerically small; that similar temporary and permanent relaxations might be found to be necessary in the interest of the safe working of the mine; and that in certain classes of mines, such as the house-coal mines of the Forest of Dean, and the thick-seam mines of South Staffordshire, the difficulty of adapting the work to the reduced hours would be so great that it might be necessary to make special regulations for such cases. Thus do we find ourselves forced into exceptions from the rule on every side; and when we note, at the same time, how closely the working-day at present approximates to an eight-hour day, bank to bank, in many parts of the country, we confess ourselves unable to see any justification for Parliamentary interference with liberty of contract in this industry.

"We have yet to consider, however, the probable effect of the proposed change upon wages. The Committee find themselves unable to give a definite conclusion on this point. But they say, 'An immediate advance of prices, wages, and demand for labour would appear to be the inevitable consequence of a legal limitation of hours, which involved an immediate reduction of output.' Few will venture to doubt this conclusion, but the point deserves fuller consideration. In most other departments of labour the ordinary economic law of supply and demand holds good; but, as the Committee point out, this is not true of the mining industry, and, consequently, in the words of the Committee, 'any effects consequent upon legislative regulation of an industry would be intensified in the case of this particular industry, both in regard to prices and to employment and wages.' Hewers are paid by piece-work on a tonnage rate, and the Committee think that by a re-arrangement of the time of working under the proposed eight-hour day it would be quite possible for hewers to spend the same total time in the mines as with the present average of 8 hours 36 minutes for full days, and to produce the same amount of coal as they do at present. The Committee, therefore, are of opinion that there is no valid reason why the introduction of such a limit to the day, taken by itself, should become the occasion of an alteration in the basis of the hewers' wages. This, however, seems to overlook the fact that the tonnage rate is itself based on an assumed day-rate, and the Committee agree that with regard to workers on a day-rating there would have to be either a retention of the present day-rate, with an increase of the real remuneration per hour, or a reduction of the day-wage in proportion to the reduction of hours. It is not to be expected that the men who demand the eight-hour day would for a moment accept the latter alternative; and if the day-wage is increased, the hewers will also demand an increase in the tonnage rate. Now, what will happen if this takes place? It has been clearly shown by the evidence that these men, when once they have earned what they consider an adequate weekly wage, take an idle day or days. An increased tonnage rate will enable them to earn that sum by a smaller number of hours of work, and when they have earned it, they will take idle days, as before. Thus the decrease in absenteeism, which the Committee look for under the new *régime*, is not, in our opinion, to be expected; and if absenteeism continues as before, the production must be still further decreased, and the increased scarcity will give rise to a demand for a still higher wage. It is only when we consider the different factors together, and not separately, that we get a proper view of the situation, and the report of the Committee suffers somewhat in this respect. We do not, however, blame the Committee, as they have strictly followed the lines of inquiry laid down for them in the terms of reference."

HONESTY IN PUBLIC CONTRACT WORK.

A DISCUSSION OF MEANS OF PREVENTING FRAUD IN THE LETTING AND EXECUTION OF PUBLIC CONTRACTS.

Cassius E. Gillette—Engineering News.

THE engineer employed in public work has no higher duty than the prevention of fraud in the execution of contracts. It is a duty which he owes to the municipality which employs him, to the engineering profession, and no less to himself. In a recent number of *Engineering News* Major Cassius E. Gillette, writing on the responsibility of the engineering profession for the conduct of public contracts, outlines the various ways in which frauds may be perpetrated and the precautions which the engineer should take in advertising for bids and in drawing specifications. The following is an abstract of the paper.

Major Gillette first emphasizes the necessity of extensive advertising of all pending contracts in papers of every political complexion and, if large, in the technical journals. An office list of contractors should be kept and notices of pending contracts should be mailed to every one on the list without request. In nearly every case of fraud the advertising has been a minimum and no office list of contractors has been kept.

"As a further check, the engineer should be required to promptly furnish to any one who asks it, full information as to the advertising of any contract, past, present or future. In every case of fraudulent contract known to the writer, the office involved has been run like a secret service bureau, where the divulging of anything official by the employees was looked upon as a serious offense, and anything like interest on the part of the public was regarded as an impudent intrusion. In this matter, it is fair to say, renegade engineers are aided by reputable engineers, who for minor reasons keep all official matters secret. After many years experience and much observation, the writer ventures the opinion that in an engineer office responsible for public work, all matters should be open to the public except those under preparation for the official action of superiors."

Finally, to prevent combinations among bidders, and especially to prevent a favored bidder from using unfair methods, there should be no requirement which would make it necessary for a bidder to let anyone else know that he is going to bid.

Major Gillette mentions the following essentials which must be observed if specifications are to provide for fair competition:

"Specifications must provide for each bidder bidding on exactly the same thing, and . . . . . . they must not be incomplete, vague or capable of two constructions. Such vagueness would deter bidders and would also enable a favored contractor to rob the public.

"The contractor should not be required to take the risk of any contingencies as to unknown conditions to be developed by the work. If the contractor is to be held responsible for the contingency, he must bid as if the contingency were sure to arise and the municipality must therefore pay for it whether it arises or not; but if the municipality take the risk, it need not be paid for unless the contingency actually arises. A contingency arising, even though covered in the bid price, can generally be used to cover fraudulent favoritism. Most contingencies can be covered by itemized bids.

"Nothing should be left to the 'discretion of the engineer' except it be definitely stated in the specifications upon what detailed principles such discretion will be exercised.

"Unit prices should be compulsory for all work subject to changes during construction. A lump sum contract coupled with the right reserved to the engineer to make changes and fix the price thereof is simply giving the engineer carte blanche in the public treasury. It is precisely the equivalent of doing the work with no specifications at all.

"While in the hands of honest engineers such provisions are all right, yet they open the door so widely to fraud that engineers who prescribe them should be looked upon just as medical men look upon a doctor who advertises fraudulent remedies. The writer has investigated contracts where many thousands of dollars had been diverted into the contractor's pockets by this process.

"Provisions should be required in every public specification to prevent robbery by unbalanced bids. This clumsy device has doubtless been in use by dishonest contractors and venal officials longer than the sandbag has been used by thugs, and is an even less reputable means of robbery.

"It consists in the engineer or other purchasing agent very much underestimating one item in his estimate of quantities used to canvass the bids. His partner in crime bids very high on this item and low on larger items. The small quantity called for in the estimate does not increase his bid much, so that it will figure out to be the lowest in the aggregate and he gets the contract, in the execution of which the great increase in the high-priced item makes his profits look like 'frenzied finance.'

"Public treasuries have been robbed of untold millions by this simple process. The remedy is to forbid the increase of any item more than ten per cent. It will occasionally happen that the quantity of some item cannot be estimated within 10 per cent. In that case all that is necessary is for the engineer to estimate the unit prices and accept no bid that exceeds any one of them by more than 10 per cent.

"Subletting of contracts should be absolutely forbidden. It frequently happens that a political boss acts secretly through an agent as a contract broker, for which service he charges what are practically enormous fees. Even where work is honestly conducted, any subletting that is done should be done by the engineer. The cost of doing it is only a trifle in comparison with the percentage which the main contractor will always add.

"The contract should be awarded invariably to the lowest bidder. This presupposes that the bids are all for identical articles or work. It also supposes that the bid is fortified by an adequate and reliable bond. With such a bond the personality of a bidder should disappear. I am fully aware that occasionally a work will be delayed by awarding the contract to some bidder who is habitually slow, or who is ill-equipped with plant or capital, but the specifications and the bond can be made to fully cover every contingency. Where trouble has been experienced with low bidders, it has been due to the fact that bonds have not been enforced and that penalties or liquidated damages have been used merely as threats to hurry contractors; and the remedy for these troubles has been sought in the objectionable method of ruling out the lowest bidder when he did not suit the engineer. This principle is wrong and opens the door to favoritism and graft.

"Even if the execution of the work is occasionally delayed by following the rule to always award the contract to the lowest bidder, if his bond is good, such loss measured in dollars will be a trifle in the long run compared with the financial losses that are inevitable under the other system. The moral loss caused by the increased opportunity for graft in public business cannot be measured in dollars.

"The names of all persons interested in the bid should be set forth in the bid itself. Every bid should be accompanied by an affidavit setting forth the names of every person having a present or future contingent interest in the bid, and vouchers for payment should contain similar affidavits as to interests in the contract.

"If the engineer is not true to his duty, contractors will sometimes pool their bids, and create a competition that is apparent but not real. This is most frequent where special plant is required, as in dredging for example. However, if the above affidavit be worded to include all persons interested 'by pooling arrangement or otherwise' the danger of such combination will disappear, especially in localities where the making of false affidavits punished as perjury.

"The profession should look askance upon any engineer who does not comply with these principles, whether embodied in local laws and ordinances or not. And if any laws or ordinances interfere with the proper compliance, their existence should be noted in the specifications."

ELECTRIC HAULAGE ON EUROPEAN CANALS.

DETAILS OF METHODS AND COSTS OF ELECTRIC CANAL TRACTION AS DEVELOPED IN FRANCE AND GERMANY.

United States Consular Reports.

THE following details of electric canal haulage methods and costs on European waterways are taken from a paper presented before the London Chamber of Commerce by Prof. E. W. Marchant of the University of Liverpool and reprinted in a recent United States Consular Report. The information forms an interesting supplement to that contained in a review in these columns in December, 1906, in which only the Teltow Canal was considered.

"In order that a system of electrical haulage may be financially successful a good and regular traffic is necessary. It is difficult to say definitely when an electrical haulage scheme becomes economically desirable on a canal, as the results obtained must depend very largely on local conditions; but on the Teltow Canal in Germany the conclusion arrived at was that the adoption of electrical haulage, on purely economical grounds (that is, taking into account only total cost of haulage, including interest and depreciation on the haulage plant) saved money when the traffic exceeded 2,000,000 tons per annum. This result applies of course solely to this canal, which is the most elaborately equipped of its kind in the world, the total cost (including generating stations), with a tractor track laid on both banks, being about £6,000 (£29,199) per mile. With a smaller capital expenditure a saving would result, of course, when the traffic was considerably less than 2,000,000 tons.

"Tractors running on an ordinary towpath have been used at Brussels, on the Charleroi Canal, and at Douai, on the Canal d'Aire et de la Deule. The advantage of this type over others lies entirely in the small cost of equipping the canal for this type of traction. The tractor used on both these canals weighs between two and three tons and carries a motor of 10 h.p. It has flat-rimmed cast-iron wheels; at Douai these wheel rims were of the corrugated form ordinarily employed for road traction engines. Current is collected from overhead wires; where continuous current (Douai) is employed only two trolleys are required, while with three-phase current (Charleroi) three become necessary. The tractor carried a seat for the driver and a controller for the motor. The cost of equipping the track with the necessary trolley wires amounts to about £300 ($1,460) per mile, using wooden poles. In spite of this the system is a very uneconomical one. The efficiency of the tractors is only 40 per cent., while the wear and tear on the machinery is very heavy.

"It will be seen, therefore, that the majority of the wearing parts require repacement in just over two years. The main drawback, however, to this system is the heavy cost of maintaining the towing path in proper condition. While horse traction requires only a light cinder or gravel track, electric traction with 2½-ton tractors requires a good macadamized road, and it was found at Douai that the average cost of upkeep was increased from 234 francs per kilometer ($45.16 per 0.6214 mile) when horses were used on the track to 875 francs ($168.87) with electric tractors. The wear on the towpath due to the running of these heavy tractors on the canal banks is particularly noticeable at Douai on that part of the canal not yet equipped with rail traction. The driver in some parts has great difficulty in maintaining his place in the tractor, even at the low speed of two miles an hour at which it is running. It is now generally agreed that this system of haulage is one that is much more costly (in spite of the small capital outlay) than haulage by means of tractors running on rails.

"The two most important installations in which electrically driven tractors running on a light railway track are used for towing canal barges are at Douai, on the Canal d'Aire et de la Deule, and on the Teltow Canal south of Berlin.

"The electric installation at Douai with rail tractors has been in operation for over a year and affords a very interesting comparison with the electrical system on the same canal, in which tractors running on the banks are used, which has been in operation since 1897. The overhead trolley wire is of the usual type used on tramways, with the exception that it is supported from below, as the trolley collector runs on top of the wire, instead of pressing against the lower side of it. The return path for the current is through the rails, which are bonded as in the ordinary tramway. The track is of rails weighing 40 lbs. per yard, laid on wooden sleepers and ballasted with cinders and broken stone, and the cost of laying is about 17,000 francs per kilometer ($5,353 per mile). The cost of upkeep of this track is estimated at under 400 francs per kilometer ($121.17 per mile). The locomotives running on this weigh eight tons and are capable of exerting a pull of 1.3 tons with the rails in their normal condition. Efforts as great as 1.6 tons have been obtained when the rails were exceptionally dry and clean. This effort is sufficient to tow four boats carrying 290 tons each, at two miles per hour. The tractor is equipped with two 20-h.p. traction motors, operated by a series of parallel controllers of the ordinary type used on tram cars. The track is laid on one side of the canal only, so that locomotives going in both directions travel on it. When two barges meet they exchange locomotives and proceed on their way. This arrangement has the advantage of keeping a locomotive driver more or less on a fixed beat. At Teltow both banks are equipped with tractors, so that no difficulty about passing occurs. The canal in this case is divided into sections, on two of which electric locomotives are used. A number of locomotives are maintained on each section—that is, they travel along the section, cross over by a bridge, and return along the other bank of the canal. It is intended when the canal is in full operation to maintain, as far as possible, a fixed time schedule for the barges, so as to avoid delay at the ends of the sections.

"The weight of the locomotives in use on each of the canals referred to is about 8 tons, and they are equipped with motors of 8 h.p. (Teltow) and 20 h.p. (nominal) at Douai. The Teltow tractors are designed to tow two barges, each loaded with 600 tons, at a speed of 2.5 miles per hour, and besides being fitted with driving motors have several special electrically operated appliances so arranged as to enable the locomotive to be controlled by one man.

"The tractors at Douai are much simpler, and are a great deal cheaper, although the two motors are of 20 h.p. The amount paid for a locomotive is 8,000 francs ($1,544), and the cost of upkeep is estimated at about $90 per annum. The tractive effort required to haul barges depends on a great number of conditions, the most important of which are the speed and the ratio of barge section to canal section. At Teltow, with a ratio of 1 : 5, and at a speed of 2.5 miles per hour, the tractive resistance is very nearly 2 lbs. per ton with a 600-ton barge. The energy consumed is 5.6 watt hours per ton-mile, costing 0.0112 cent per ton-mile, and the efficiency of the locomotive is 67 per cent. At Douai, on the Scarpe detour of the Canal d'Aire et de la Deule, the ratio of barge section to canal section is 1 : 5.22. On the main canal it is only 1 : 3.80; at a speed of two miles per hour the tractive resistance is 2.5 lbs. per ton, with 200 or 300-ton barges. The energy consumed per ton-mile is 7.2 watt hours, costing 0.0144 cent per ton-mile, and the efficiency of the locomotive 68 per cent. It is significant that no greater speed than 2½ miles an hour is allowed on the German canals, while on the French canals a limit of two miles an hour is given. The objections to a higher speed are the increase in the silting up of the canal, the greater wear on the banks, and the greatly increased tractive effort required. All experience shows the inadvisability of increasing the speed of towing on canals to any very great extent, whatever method of haulage is employed.

"The total cost of electrical haulage on the Teltow Canal for different traffics are as follows: At a total traffic of 2,000,000 tons, 1.72 cents per ton-mile; traffic of 3,000,000 tons, 1.48 cents per ton-mile; traffic of 4,000,000 tons, 1.2 cents per ton-mile. At Douai the gross receipts per ton-mile (net load) were 1.32 cents, and the expenses 0.94 cent. Of the expenses 0.0352 cent represents the cost of energy used for barges and the remainder the upkeep charge on the plant, labor charges, etc. The traffic on this canal has increased from 1,000,000 tons in 1900 to over 3,500,000 tons last year.

"One of many great advantages which the use of electrical energy possesses over all other methods of mechanical towing is the fact that it gives a supply of power available within limits at any point on the canal banks. Some of the uses to which electrical energy has been put on the canals where electric haulage has been adapted are as follows: Electric capstans are used at the lock; electric cranes at loading places; electrically driven winches are used at a harbor designed for ship repairs by which any boat up to 150 feet long can be hauled out of the water on carriers, thus obviating the necessity for a dry dock; an electrically driven pump is fitted at the lock to pump back water into the upper reach (Havel), in case the loss by lockage is too great, and electric lights are placed at the lock to enable it to be used at night; electric power has been used for lighting a canal, and for operating locks and swing bridges, the saving in labor effected by its use being estimated at 50 per cent.

"Electrical haulage has only proved successful on canals on which there is a good volume of traffic. In all successful installations electric locomotives running on the towpath have been employed in preference to tugs. The economy in general upkeep of the canal in getting rid of the wash from the screws is sufficient, in some cases, to compensate for the interest and depreciation charges on the electrical equipment. The total cost of electrical haulage per ton-mile at Douai is $.094 cent, with a traffic of 3,500,000 tons per annum."

A CODE OF ENGINEERING ETHICS.

A SUMMARY OF THE PROPOSED CODE OF ETHICS DRAWN UP BY A COMMITTEE OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Proceedings of the American Institute of Electrical Engineers.

ONE of the most valuable functions of the great national engineering societies is the establishment and maintenance of high standards of professional conduct. The American Institute of Electrical Engineers recently appointed a committee to formulate a code of ethics, the report of which was presented at the last annual convention. This committee, composed of Chas. P. Steinmetz, Harold W. Buck, and Schuyler S. Wheeler, considered it impracticable to cover explicitly all the conditions met with in the work of the electrical engineer and laid down only the general principles of professional conduct. Many of the points mentioned in the code, therefore, apply equally well to all branches of the engineering profession.

In the first section of the code the electrical engineer is advised to investigate fully the character of every concern before entering into professional relations with them, even if he is employed to perform only legitimate engineering work. An engineer permitting the use of his name in any enterprise becomes morally responsible for the character of the latter. He should also take care that the credit for engineering work is attributed to the real authors of such work.

Regarding the relations of the electrical engineer to his employer, customer, or client, the report lays down the following rules:—

"The electrical engineer should consider the protection of his client's interests as his first obligation, and therefore should avoid every act that would be contrary to this duty; if any other consideration such as professional obligations or restrictions interfere with his so acting, in accordance with the expectation of his client, he should inform him of the situation.

"He can honorably accept compensation, financially or otherwise, from one side or party only, interested in the same matter. The electrical engineer, whether consulting, designing, or operating, may therefore not accept commissions, either directly or indirectly, from other parties dealing with his principals.

"Electrical engineers in a position to decide on the use of inventions, apparatus, etc., should not be financially interested in their use, as by receiving a royalty, etc., unless the matter is clearly understood by the client.

"Electrical engineers should not accept employment while financially interested in a rival concern except upon the express permission of both parties. An electrical engineer may be employed by more than one party, as in the case of a consulting engineer, when the interests of the parties do not conflict and it is understood, as is usual in such cases, that he is not expected to devote his entire time to the work of one party, but is free to enter into other engagements. A consulting engineer permanently retained by a party should notify other prospective employers of this affiliation before entering into relations with them. A consulting engineer when not exclusively retained by one side may advise rival concerns, with the full knowledge of all of them and upon taking care that the interests of the parties do not conflict in the particular matter handled.

"Operating engineers should consider themselves responsible for defects in apparatus or dangerous conditions of operation, should bring the same to the attention of their employers and urge remedial action. If the causes of danger are not removed they should withdraw.

"An electrical engineer should in general be considered directly responsible to his employer or client for the successful fulfilment of the work upon which he has been engaged and for its satisfactory performance as a whole. It should therefore be clearly understood at the outset just what the extent or the limitations of responsibility of the engineer are to be. Whether he has been employed merely as a designer or whether he is retained to design and to superintend construction; whether to design only the chief features, or to pass as well upon all details of the apparatus that is to be installed. Attention should be directed to the fact that defects in the manufacture of material or apparatus is a matter distinct from the matter of design or installation. An engineer should not be held responsible for the unsatisfactory performance of a plant resulting from defective apparatus furnished, unless he has undertaken to include the subject."

With regard to the ownership of the records of the electrical engineer, the code states:—

"If in executing his work, the electrical engineer uses data or information which are not common and public property, but which he receives, directly or directly from his employer, and is not of such character that his attention would have been directed to it regardless of his relations to his employer, the products of his work, in the form of inventions, plans, designs, etc., are not his private property, but the property of his employer, though the engineer may be entitled to special remuneration for such inventions, etc.

"If in the execution of the work the engineer uses only his own knowledge or data or information which are public property by prior publication, etc., and receives no engineering data from his employer or customer, except performance specifications, the results of his work, such as inventions, plans, designs, etc., are the private property of the engineer, and his employer or customer is entitled to their use only in the specified case.

"All the work done by the engineer in the form of inventions, plans, designs, etc., which are outside the field of engineering for which his employer has retained him are the engineer's private property.

"When an engineer or manufacturer builds apparatus from engineering designs supplied to him by his customer, the designs remain the property of the customer and should not be duplicated for other customers without express permission. When the engineer or manufacturer and his customer are jointly to work out designs and plans or develop inventions, a clear understanding should be arrived at before the beginning of the work regarding the proportionate rights of ownership in any inventions, designs, etc., that may result, since in such case both parties should be considered to have rights therein.

"Any engineering data or information which an electrical engineer obtains, directly or indirectly, from his employer or customer, or which he creates as a result of such information, must be considered by the engineer as confidential; and while the engineer is justified in using such data or experience in his own practice as going towards his education, the publication thereof without express permission is improper, as is also its use in producing for other parties, work that is characteristic of the original customer or employer.

"Designs, data, records and notes made during his engagement by an engineer employed under permanent engagement, and referring to his work, are his employer's property. The same matter in the case of a consulting electrical engineer are the property of the consulting engineer.

"A customer, in buying apparatus, does not acquire any right in its design beyond the use in the apparatus purchased. A customer of a consulting engineer does not acquire any right to the plans made by the consulting engineer except for the specific case for which the apparatus was built or the plans made."

The proper relations of the electrical engineer to the general public are specified thus:—

"The electrical engineer should endeavor to assist the public to a fair and correct general understanding of engineering matters, spread the general knowledge of electrical engineering, and discourage wrong or exaggerated statements on engineering subjects published in the press or otherwise, especially if these statements are made for the purpose of, or may lead to inducing the public to participate in unworthy schemes.

"Controversies on engineering questions, however, should never be carried on in the public press, but should be confined to the technical press and the engineering societies.

"First publication of inventions or other engineering advances should not be made through the public press but rather through the technical press and the engineering societies.

"The publications which an electrical engineer is justified in making through the public press should therefore be of a historical, educational, instructive or similar character and should not relate to controversies between engineers or on engineering questions, to new inventions, etc., nor contain technical criticisms of fellow engineers, and it should be considered unprofessional to give opinions without being fully informed on all the facts relating to the question, and on the purposes for which the opinion is asked, with a full statement of the conditions under which the opinion applies.

"In giving expert testimony before judicial bodies, the electrical engineer should confine himself to brief and clear statements on engineering or historical facts. He should not give personal opinions with- He should not give personal opinions with- pleading on one side or the other."

THE PUBLIC UTILITIES LAW OF NEW YORK.

A DISCUSSION OF THE REGULATION OF CORPORATIONS BY COMMISSIONS AND OF THE NEW PUBLIC SERVICE COMMISSION OF NEW YORK.

Engineering News.

MR. KERRY'S article on the Canadian Railway Commission in another part of this number of THE ENGINEERING MAGAZINE describes a notable attempt to obtain national control and regulation of public service corporations, the jurisdiction of this commission being limited, however, to transportation companies. Recent legislation in New York State has created a commission with somewhat similar powers, operating of course over a smaller area but with its sphere of influence enlarged to include gas and electric lighting companies. An editorial in a recent number of *Engineering News* makes some interesting comments on this new law and on the general question of government control of corporations by means of commissions.

"By the terms of the law, the whole state is divided into two districts, the first comprising the city of Greater New York, and the second, all the rest of the state. In each of these districts a 'Public Service Commission' of five members is created and is given jurisdiction over all railways, street railways, common carriers, and all works for distributing gas or electricity for light, heat or power. It will be seen that several other important classes of public utility corporations operating under franchises, such as water companies, and telephone companies, are not included. The term 'common carrier,' however, includes express companies, sleeping car companies, and freight line companies.

"Turning now to the powers to be exercised by these Commissions, it should be said that for the most part the requirements are the same as those of existing law. Discrimination between persons and places, false billing, free passes, and similar practises are prohibited as in existing laws. In addition, however, the Commission is given full authority over all the operations of the corporations under it. While the primary responsibility is on the corporations to render good service to the public and charge only reasonable rates, the Commission has full authority to inquire into and compel the remedying of any dereliction in either respect. It is because the bill does go further than any previous measure in clothing the Commissions with power over these public service corporations, that such a measure of opposition from the corporations has been aroused.

"It is around the requirement that 'all rates shall be reasonable,' that future controversies are certain to be waged. No one objects to this provision. Every corporation officer will deny that his company ever charges a rate that is unreasonable. But when we get down to the definition of a reasonable rate, the two sides are far apart. It will be one of the most difficult duties of the new Commissions to frame a definition of a reasonable rate—one which will be accepted alike by the public and by the corporation managers, and which will stand the test of the courts. It is even among the possibilities that the constitutional powers of the new Commissions may be found inadequate for the settlement of this question. It may be necessary to resort to the legislature for the enactment of a law defining in general terms what conditions a reasonable rate charged by a public service corporation shall fulfil.

"Quite as important a part of the law as the clauses defining the powers of the Commission are those fixing its make-up. In nearly or quite all previous attempts at state regulation of monopolies, the mistake has been made of creating a regulating body inadequate in numbers and too poorly paid to secure efficient service. What would be thought of a Board of Bank Directors who employed a two-dollar a day laborer to watch a ten-thousand dollar a year cashier and prevent him from making way with the funds? Yet this is on a par with most of the experiments which have been made in regulation of railways by State Commissions.

"For the first time now, the State of New York recognizes that the task of controlling the public service companies of the state with their billions of dollars of capital is a task demanding all the energies and time of the highest class of men that can be secured; and it has declared its willingness to pay the market price for such men. Each of the five members of each Commission is to have a salary of $15,000 per annum and his expenses. The contrast between this and all previous attempts at Commission control over corporations is one which the corporations themselves fully appreciate. It ought to be possible to secure for this sum men of as high character and standing as the judges in the courts of law, or those who lead in other professions, or those at the head of private business enterprises.

"Of course it goes without saying that men who can be purchased or controlled by influence can nullify the intent of the law to protect the public from extortion, while a demagogue could misuse such a position with resultant disaster to the vast interests dependent on his decisions. But exactly the same thing may be said of the men in executive positions, or in the legislature or on the Bench. The public must trust someone; and there is no reason apparent why the men on the new public service commissions should not be as deserving of trust and public confidence, and as likely to give the corporations as well as the people a square deal as any officers of the legislative, executive or judicial department of Government.

"We see absolutely no justification for the outcry against 'Government by Commissions,' which the corporation defenders are emitting. Chancellor Day of Syracuse University, who is doubtless the most unique representative of the corporations, in his baccalaureate 'sermon' on June 9 is quoted as saying:

"'The distinction between the executive, judicial, and legislative order is disappearing in a form of oligarchy named "commissions.

"'The laws are taken out of the hands of Congress and the legislature and put into the hands of commissions, subject to executive appointment and executive pleasure.'

"The facts are, however, that the delegation of certain Governmental functions to Commissions is an absolutely necessary step in the evolution of Governmental machinery. No legislature and no court can possibly do the work that modern conditions make it necessary for the Government to undertake. A Commission is nothing more than a body of executive officers to whom a particular task is assigned.

"The absurdity of the position that the law of supply and demand is sufficient protection for the people has been proved over and over again. Every honest and intelligent authority on public questions recognizes that there are to-day only two alternatives, if 'government of the people, by the people and for the people is not to perish from the earth.' These alternatives are Government control of monopolized industry or Government ownership. It is the former alternative which the State of New York is about to attempt; and every intelligent and patriotic citizen will watch the operation of the new Public Utilities law wth hopeful interest.

"In conclusion, we may appropriately express the opinion that in the selection of members for the new Commissions, the engineering profession should be adequately represented. These Commissions must investigate and render opinions upon many technical questions in connection with the operation of railways, electric plants, gas plants, etc. It will be of great advantage if the Commissions are not obliged to rely wholly on experts whom they may hire, but have in their own membership men able to form intelligent opinions on any technical matter brought before them. The other necessary elements in the candidates, such as moral and professional standing, fidelity to duty, judicial temperament and broad culture, can surely be found among members of the engineering profession as readily as among those engaged in any calling."

ROCK DREDGING.

EXPERIENCES IN THE REMOVAL OF SUBAQUEOUS ROCK BY MEANS OF THE LOBNITZ ROCK BREAKER.

E. Quellennec and J. W. Sandeman—Institution of Civil Engineers.

THE removal of subaqueous rock has, up to comparatively recent times, been accomplished altogether by drilling and blasting, at best a laborious and costly process, and attended in navigable waters with great inconvenience to shipping. Recent experiences on several large works have shown, however, that many of the difficulties of rock removal under water can be overcome by the use of heavy rock breakers which not only effect a saving in the cost of excavation but leave the material in a much more satisfactory state for handling by bucket dredges. The following details of dredging by the rock breaker method are taken from papers presented by Messrs. Edouard Quellennec and John W. Sandeman at the Engineering Conference of the Institution of Civil Engineers.

Mr. Quellenec's paper deals with experiences extending over twenty years on the dredging work for the Suez Canal Company.

"Hitherto rock has only been encountered in the southern portion of the Suez Canal, comprised between kilometre .85 and Suez (kilometre 160), a distance of 46 3-5 miles. This rock is found in the form of nearly horizontal layers of variable thickness, scattered throughout the whole of this region in beds of very different lengths, generally less than 100 metres (328 ft.), and never exceeding 400 metres (1312 ft.); and these beds of rock stretch across the whole width of the canal. The total area of rock actually met with in the bed of the canal amounts to 300,000 square metres (358,800 square yards). The rock is very variable in composition, consisting of limestone more or less hard, calcareous or silicious agglomerates, generally containing shells, calcareous tufa of a red colour, gypsum, and alabaster. The hardness, also, of these strata is very variable; generally they are not very hard; but, nevertheless, there are some beds of compact limestone and silicious conglomerates which are very hard. In constructing the canal, the rocky beds were excavated out of water.

"In 1884, when the company determined to enlarge and deepen the canal, the problem of removing the rock under water had to be considered. It was then decided to disintegrate the hardest rock (compact limestone and silicious conglomerate) by subaqueous mines; but the company accepted the proposal of Mr. Lobnitz, of Renfrew, to use a rock-breaking dredger in dealing with rock of average hardness. This dredger consisted of a set of ten steel rock-cutting rams, each weighing 3½ tons, placed on a very strongly-constructed bucket-ladder dredger, which could easily raise the rock shattered by the rams. Mr. Lobnitz's idea was not new, since for forty years the system of shattering rock under water by rams has been employed at the port of Cette in France; but Mr. Lobnitz has made improvements in the construction of the rams, and has devised various contrivances for the suspension of the rams and the arrangement of the winches, which have rendered the rock-breaking apparatus thoroughly practical and economical. It soon became evident in working that Mr. Lobnitz's rock-breaking dredger did not furnish an advantageous output, owing to the mistake of having combined two such different tools as a chain of buckets and a rock-cutter on the same vessel; for when one of them is working the other is necessarily idle. The rams were consequently removed from the dredger, and installed upon special pontoons. The output was thereby considerably increased, but it still remained moderate, owing to the insufficient weight of the rams; for fourteen to sixteen blows of the ram were required to shatter moderately hard rock for a thickness of only 20 in., so that the breaking up of rock cost on the average 7s. 3½d. per cubic yard.

"When in 1897 it was decided to deepen the canal to 31 ft. the removal of the rock had to be considered again, and an investigation of the method of extracting the rock by mining and explosives proved that it could not compare in economy with rock-cutters. Moreover, the experience gained with the little rams of 3½ tons, and later on with rams of 5 tons, furnished an assurance that the employment of heavier rams would solve the problem in a very satisfactory manner. Besides, in the special case of the Suez Canal, the use of explosives is subject to numerous inconveniences, from which rock-cutters erected on floating barges are exempt, especially with regard to the obligation of being drawn to one side for the passage of ships, and the necessity for divers to examine the bottom after every explosion, to ensure that no pieces of exploded rock project from the bottom. Finally, it must be borne in mind that with rock-cutters the bottom is leveled off in a fairly regular manner; whereas with explosives it is always necessary to remove a large quantity of rock below the intended level, which is the reverse of economical.

"An apparatus was finally selected, of the type designed by Messrs. Lobnitz and Co., provided with two spindle-shaped cutters of cast steel, 44 ft. 7½ in. long, each weighing 13 tons. These cutters have renewable points of very hard chrome-steel, which have been turned in order to obtain a more regular form, and also to enable the soundness of the metal on its whole surface to be verified. The cutters, or rams, placed

1 metre (3 ft. 3⅓ in.) apart, are lifted by powerful steam-winches, rapidly put into and out of gear, by means of very flexible steel cables securely fastened to the head of each ram, which arrangement admits of a very rapid raising of the rams, and the easy regulation of the height of their fall, which is usually between 5 and 10 ft. All the movements of the rock-cutting pontoon, forwards, backwards, and sideways, are rapidly accomplished by means of steam winches. The principal dimensions of the floating pontoon carrying the two rams are 100 ft. in length, 35 ft. beam, and 8 ft. in depth of hold. This apparatus, which commenced operations in 1902, after undergoing some improvement in details, has given very satisfactory results. On the average 132 blows are delivered per hour of effective rock-breaking; but allowing for stoppages, for repairs, and drawing to one side to leave the waterway clear, 83 blows are delivered by the ram per hour of work paid to the crew. The average thickness of the bed of rock shattered is 2 ft. 7½ in.; and under these conditions, the number of blows required for the shattering of a cubic metre varies, according to the hardness and also the fragility of the rock, from 1 to 40; but 40 blows is a maximum very rarely reached, and the mean is 7.1 blows per cubic metre, equivalent to about 5.4 blows per cubic yard of rock shattered.

"The cost price per blow of ram is made up as follows:—

Cost of Operations.	Small Repairs.	Large Repairs.	Repayment of Capital.	Total.
0.160*f.* +	0.034*f.* +	0.044*f.* +	0.073*f.* =	0.311*f.*
1.53*d.* +	0.328*d.* +	0.422*d.* +	0.701*d.* =	2.985*d.*

"As from 1 to 40 blows are required to shatter 1 cubic metre of rock, with a mean of 7.1 blows, the cost per cubic metre varies from

Francs. Francs. Francs. s. d.
0.311 × 1.0 = 0.311, equivalent to 0 2.26 per cubic yard
to
0.311 × 40.0 = 12.44, equivalent to 7 6.57 per cubic yard
with a mean of
0.311 × 7.1 = 2.21, equivalent to 1 4.10 per cubic yard

"These prices include all expenses, with the sole exception of general charges. To these should be added the cost of raising the shattered rock by the dredgers, and transporting it to the place of deposit. These expenses vary greatly according to the locality, and especially with the distance from the depositing ground; whilst the cost of dredging the shattered rock is about double the cost of dredging in average ground."

Mr. Sandeman's paper contains the following details of the use of the rock-breaker in harbor-improvement work now in progress at Blyth, on the north-east coast of England.

"Under the scheme of improvement now in progress at Blyth, about 500,000 cubic yards of sandstone rock and shale have to be removed, and this is being accomplished by means of two of Lobnitz rock-breakers and two 700-ton hopper dredgers. Previous to 1906, about 150,000 cubic yards of rock were broken up by means of drilling and blasting, so that a comparison of the two methods may be of interest.

"The rock at Blyth is the sandstone of the Coal Measures, which varies in character from friable stone, containing fireclay, shale, and coal, to sandstone equal in hardness to basalt.

"Each rock-breaker consists of a steel barge carrying sheer-legs, from which is suspended a steel ram of 15 tons weight, 40 ft. to 50 ft. in length, and 17 in. to 19 in. in diameter, having a renewable conical point, tempered so as to combine a hard centre with a softer exterior, which, while wearing, enables a sharp point to be preserved.

"The ram is lifted by a wire rope wound upon a loose drum, driven by a friction-clutch. It is allowed to fall from a height of 8 ft., and on an average of eight to nine blows penetrates the rock to a depth of 3 ft., which is sufficient to allow of its being dredged to a depth of 2 ft. 6 in. The machine is arranged so that it can be moved on end and athwart simultaneously by chains worked by steam-winches. By means of sighting-rods on board and ashore, the barge can be moved over uniform distances. The ram was at first worked in positions 3 ft. apart, and this distance was gradually increased to 4 ft. 6 in., which was found to be close enough for either hard or soft rock.

"The average quantity of rock which one machine has broken per week, working night and day, and allowing for all stoppages, is 908 cubic yards, at a cost of 8.8d. per cubic yard. This is based on six months' working; but as it is necessary to allow for renewal of rams, the following is the actual cost per week of wages, coal, stores, and water, and the estimated cost of repairs, full allowance being made for renewal of rams and all contingencies:—

	£	s.	d.
Wages	16	1	6
Coals, stores, and water	6	10	7
Estimated cost of repairs, renewal of rams, ropes, &c.	22	0	0
Insurance at 30s. per cent. = 102*l.* per annum	1	19	2
	—	—	—
908 cubic yards at 12.3d.	46	11	3

"The cost of one rock-breaker is about 6800*l.*, and if 4 per cent. be allowed for interest and 2½ per cent. for depreciation (the machine being well maintained), the additional cost per cubic yard would be 2.2d., making a total cost of about 14.5d. per cubic yard. The quantity of rock broken is ascertained by the number and depths of the penetrations of the ram in a given time, which are carefully recorded; and, after dredging, the amount of rock removed is checked by soundings.

"The drilling and blasting of the rock was carried out by means of a barge having six drills, which were lifted by steam-power and guided by hand. The distances between the shot-holes were 5 ft. in one direction, and 6 ft. 2 in. in the other. The blasting material, bellite, was lowered in canisters through the drilling-tubes, and fired by fuses and detonators, the holes being tamped with small gravel.

"The average quantity of rock drilled and blasted per week by means of one barge was 488 cubic yards, and the average cost of drilling and blasting was about 3s. per cubic yard. The quantity of rock blasted was ascertained by the number of holes and their depth, which was 1 ft. more than that to which the rock could be dredged, and a check was made by sounding over an area of rock before blasting and after dredging.

"Each of the hopper dredgers has two sets of buckets, one for rock-dredging, and the other for sand, clay, or gravel, having 50 per cent. greater capacity. The bucket lips are of cast-steel, and the pins and bushes of manganese steel. The lips of the buckets for rock-dredging are set at an angle of about 27 deg. to the bucket-backs, and those for sand, &c., at an angle of 55 deg. The rock is dredged into hoppers and deposited at sea, or (when required for harbour purposes) into separate barges having gridded hoppers, enabling the rock to be screened and discharged.

"In estimating the quantity of rock carried in the dredgers' hoppers, deduction has been made for water contained along with the rock.

"As compared with blasting, the rock-breaker disintegrates and breaks the rock into smaller pieces, so that the quantity lifted by the dredgers in a given time is about 15 per cent. more than that of blasted rock. The average quantity of blasted rock removed by one dredger per day of 24 hours, and allowing for all stoppages, is 158 cubic yards, and of that broken by the rock-breaker 182 cubic yards. The average number of days per annum worked by the dredgers is 227. The cost per cubic yard of dredging blasted rock is 2s. 6d. The cost per cubic yard of dredging rock broken by rock-cutter is 2s. 2d.

"Allowing 4 per cent. for interest, and 2½ per cent. for depreciation on 19,000*l.*, the cost of a dredger (as they are well maintained), the additional cost per cubic yard would be 8.2d. for blasted rock, and 7.1d. for rock broken by rock-breaker.

"The comparative cost of rock removal under the two systems is as follows:—

	Per Cubic Yard.	
	s.	d.
Drilling and blasting rock	3	0
Dredging same 2s. 6d. + 8.2d.	3	2.2
	6	2.2
Breaking rock by rock-breaker	1	2.5
Dredging same, 2s. 2d. + 7.1d.	2	9.1
	3	11.6

Difference in cost per cubic yard in favour of the removal of rock by means of rock-breaker = 2s. 2.6d.

Saving on 500,000 cubic yards = 54,166*l.*"

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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Anchorage.

The Manhattan Anchorage of Manhattan Bridge. C. M. Ripley. Describes the work of building this anchorage, commenting on the volume of masonry and extensive use of concrete. 2500 w. Munic Engng—June, 1907. No. 85176 C.

Bascule.

Page Single-Leaf Double-Track Bascule Railroad Bridge Over the Chicago River. A. R. Ekstrom. Illustrated description of a bridge replacing a swing bridge, so as to give a clear channel to navigation. 1200 w. R R Gaz—June 14, 1907. No. 85074.

Blackwell's Island.

Progress of the Blackwell's Island Bridge Erection. Information from the official report of May 11, 1907, with illustrated description of recent work. 1600 w. Eng Rec—June 8, 1907. No. 84849.

The Erection of the Western Half of the Blackwell's Island Bridge. Illustrated description of work on this bridge across the East River, at New York. 1000 w. Eng Rec—June 15, 1907. No. 85063.

Concrete Arch.

The Piney Branch Concrete Arch Bridge at Washington, D. C. W. J. Douglas and W. P. Darwin. Illustrates and describes the method of laying the arch ring, centering, etc. 1800 w. Eng News—June 20, 1907. No. 85156.

Masonry.

The Queen's Bridge at The Hague (De Witte—Koninginne—brug te's—Gravenhage). F. C. J. van den Steen. An illustrated description of this masonry bridge giving the calculations made in its design. 9000 w. De Ingenieur—May 4, 1907. No. 84989 D.

New York City.

Proposed East River Bridge; New York Connecting Railroad. Illustrations showing the proposed bridge at Ward's and Randall's islands which will join the belt line now building from Bay Ridge on the harbor, with the Harlem River branch of the New York, New Haven, & Hartford. 1200 w. R R Gaz—May 31, 1907. No. 84671.

Plate-Girder.

A Six-Track Solid-Floor Plate-Girder Bridge. Illustrated detailed description of bridge 60 on the main line division of the D. L. & W. R. R. at Scranton, Penna. 2000 w. Eng Rec—June 22, 1907. No. 85198.

Quebec.

The Quebec Bridge Superstructure Details. Illustrated detailed description. 1000 w. Eng Rec—June 22, 1907. Serial. 1st part. No. 85202.

Steel.

The Bridge over the Rhine between Ruhrort and Homburg (Die Straszenbrücke über den Rhein zwischen Ruhrort und Homberg). W. Dietz. The first part of the serial deals principally with the foundations for this steel structure. Ills. 4000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—May 11, 1907. No. 84979 D.

The Railway Bridge over the Gorge of the Schwarzwasser (Die Eisenbahnbrücke über das Schwarzwassertobel). Fritz Ackermann. Gives details of this high, long span, arch bridge. Ills. 1500 w. Schweiz Bau—May 11, 1907. No. 84964 B.

Suspension.

The Bridge "Humbert I" over the Po at Turin (Il Ponte Umberto I sul Po a Torino). F. Corradini. An illustrated description of the design and construction of this suspension bridge. Serial. 1st part. 1500 w. Il Monitore Tech—May 30, 1907. No. 84926 D.

Tubular.

Tubular Bridges. Illustrates and describes famous bridges of this design. 1500 w. Ry & Loc Engng—June, 1907. No. 84772 C.

Viaducts.

Cost of Erecting Three Steel Viaducts of 500 ft., 580 ft., 1170 ft. Length, with Summaries of Costs of Labor and Materials and New Formula for Computing the Weight of Viaducts. 3000 w. Engng-Con—June 19, 1907. No. 85144.

CONSTRUCTION.

Buildings.

The Baltimore & Ohio Office Building, Baltimore. Describes the construction of a 13-story and basement building, giving typical beam plan and details. 3000 w. Eng Rec—June 1, 1907. No. 84703.

Erection of the City Investing Company's Building. Illustrated description of the erection of a 32-sotry steel-cage building in New York City. 2000 w. Eng Rec—June 15, 1907. No. 85055.

The Construction of the Trust Company of America Building, New York. Illustrated description of methods of erection used in advanced fireproof steel cage construction. 3300 w. Eng Rec—June 22, 1907. No. 85205.

The Salvation Army Building, New York. Describes the system of self-supporting reinforcement used in the erection of this fireproof six-story structure. Ills. 1800 w. Eng Rec—June 22, 1907. No. 85203.

Compressed Air.

The Equilibrium of Floating or Immersed Vessels Filled with Compressed Air (Equilibre des Appareils Flottants ou Immergés renfermant de l'Air Comprimé). Edmond Henry. A mathematical discussion referring particularly to caissons, diving bells and other construction devices. Ills. Génie Civil—May 25, 1907. No. 84910 D.

Concrete.

Progress in Construction of Concrete Country Houses. Benjamin A. Howes. Discusses recent applications of this material to the economical construction of attractive and satisfactory homes. Ills. 1800 w. Cement Age—June, 1907. No. 85267 C.

Concrete Pier.

The Cost of a Coffer Dam and Concrete Pier on Pile Foundation. Briefly describes the work, giving analysis of cost. 1400 w. Engng-Con—May 29, 1907. No. 84664.

Contractor's Plant.

The Contractor's Plant and Methods Used on the Minidoka Irrigation Project. Outlines this work in southern Idaho, giving an illustrated description of methods employed. 2800 w. Eng Rec—June 22, 1907. No. 85201.

Contractors' Plant for Constructing the Reinforced Concrete Warehouse of Montgomery Ward & Co., Chicago, Ill. Illustrated description of a field plant for handling and working up 7,500 tons of reinforcing steel and 4,000,000 ft. B. M. of form lumber, and for mixing and laying 125,000 cu. yds. of concrete. 2200 w. Engng-Con—May 29, 1907. No. 84663.

Fire-Proof.

Fire-Proof Construction. A review of criticisms of experts in recent reports to the Government on the condition of buildings after the San Francisco disaster. 5000 w. Eng Rec—June 15, 1907. No. 85056.

Foundations.

Constructing Elevated Railroad Foundations Over a Large Sewer. Illustrates and describes unusual foundation work in connection with the extension of the New York Rapid Transit Railroad system. 2000 w. Eng Rec—June 8, 1907. No. 84851.

Tall Building Foundations on Soft Clay. Describes tests made preparatory to the erection of the Traders' Bank of Canada, at Toronto, to determine the bearing capacity of the soil. Ills. 1600 w. Eng Rec—June 22, 1907. No. 85200.

The "Compressol" System of Making Foundations. Illustrated description of an improved type of the "Compressol" machine, describing the operation and the process. 1200 w. Engng—June 7, 1907. No. 85114 A.

Foundry Buildings.

The Design and Construction of Foundry Buildings. George K. Hooper. Read before the Am. Found. Assn. Describes some of the plants designed by the author. 4500 w. Eng Rec—June 1, 1907. No. 84704.

House Moving.

Novel House-Moving Operations. Edward H. Crussell. Illustrates and describes method of loading a building on cars, and anchoring to loaded coal cars, for removal along a railway. 1000 w. Sci Am Sup—June 22, 1902. No. 85165.

Levees.

Cost of Riprap Paving, Brush Mattresses and Brush Dikes for a Levee Protection. Gives data of protection work at the West Pass levee in Mississippi. 1100 w. Engng-Con—May 29, 1907. No. 84665.

Planning Works.

The Planning of Contractors' Work. John S. Ely. Discusses the importance of planning to execute the work in the least time at a reasonable cost, illustrating by example. 2000 w. Engng-Con—June 19, 1907. No. 85145.

Reinforced Concrete.

A Reinforced Concrete Laundry Building. Brief illustrated description of a three-story building in Newark, N. J. 900 w. Eng Rec—June 8, 1907. No. 84852.

The Roman Catholic Parish Church in Pressbaum (Die Katholische Pfarrkirche in Pressbaum). Josef Gaugusch. Illustrates and describes details of design and construction of this reinforced concrete structure. Plate. 1500 w. Beton u Eisen —May, 1907. No. 84954 F.

Retaining Walls.

On a More Convenient Section for Retaining Walls (Sul Profilo più Convenienti dei Muri di Sostegas delle Terre). Giulio Stabilini. Mathematical discussion of strength of retaining walls of various sections. Ills. Serial. 1st part. 4000 w. Il Monitor Tech—May 10, 1907. No. 84924 D.

Roads.

General Method of Preparing Plans and Estimates for New York State Highways. Information from a pamphlet issued by the State Engineer. 3300 w. Eng Rec—June 22, 1907. No. 85206.

Rock Drills.

The Rock Drill and Its Share in the Development of New York City. Frank Richards. A fully illustrated article showing the value of the work of the rock drill in New York. 3500 w. Cassier's Mag—June, 1907. No. 85184 B.

Specifications.

The Enforcement of Specifications. Charles B. Dudley. Presidential address before the Am. Soc. for Testing Materials. 9500 w. Ir Age—June 27, 1907. No. 85293.

Trestles.

Hints on the Design and Construction of Wooden Trestles. R. Balfour. Briefly considers the conditions under which the timber has to do its work, and gives designs, discussing their construction. 1200 w. Eng News—June 6, 1907. No. 84814.

Tribune Building.

The Extension of the Tribune Building, New York. An illustrated description of the work of increasing a building from 10 to 20-stories, and the methods of providing for the stresses. 4500 w. Eng Rec—June 1, 1907. No. 84699.

Tunnels.

Driving Concrete Piles Below the Battery Tunnel, New York. Describes the provision made for possible vibrations and abrupt changes of support in the tubes driven under the East River, where they pass through sand. 1600 w. Eng Rec—June 8, 1907. No. 84853.

Grade Correction and Pile Foundations in the East River Tunnel of the New York Rapid Transit Subway. Explains the conditions which led to the use of pile foundations to assure permanent stability, and the method of carrying out the work.

2000 w. Eng News—June 27, 1907. No. 85303.

The Belmont Tunnel, New York. Describes briefly the construction of the two parallel single-track tunnels under the East River at 42nd St. Ills. 2500 w. Eng Rec—June 8, 1907. No. 84857.

Mining Operations in New York City and Vicinity. H. T. Hildage. A general description of some of the methods and appliances used in the opening-up of a "mine" in a large city, and a brief description of some of the "mines" now being developed in New York. 10500 w. Bul Am Inst of Min Engrs—May, 1907. No. 85272 C.

The Karawanken Tunnel. Illustrates and describes the construction of this tunnel in Austria, especially interesting because of the rapidity of execution. 1200 w. Engr, Lond—May 24, 1907. No. 84759 A.

The Machinery Used in the Construction of the Tauern Tunnel (Die Maschinellen Anlagen beim Bau des Tauerntunnels). K. Brabbée. Illustrated description of drilling machines, pumping plant, power plant, etc. 6500 w. Zeitschr d Ver Deutscher Ing—May 25, 1907. No. 84984 D.

The Boring of the Simplon Tunnel (Come Venne Forato il Sempione). Describes the geology, the drills used, the difficulties encountered, pumping and ventilating arrangements, etc. Ills. 1500 w. L'Elettricità—May 17, 1907. No. 84920 D.

The Construction of the Simplon Tunnel (Der Bau des Simplontunnels). Herr Pressel. A complete description of this work. Ills. Serial. 1st part. 4200 w. Glasers Ann—May 15, 1907. No. 84957 D.

Underpinning.

Cantilever Underpinning in Boston. Illustrates and describes ingenious cantilever underpinning with suspended fulcrums, used in the construction of the Boston Transit Commission's subway. 1000 w. Eng Rec—June 15, 1907. No. 85057.

MATERIALS OF CONSTRUCTION.

Asbestos Wood.

Fire Test of Asbestos Wood. C. L. Norton. Illustrated account of test, proving the excellence of its non-conducting and non-radiating properties. 1000 w. Ins Engng—June, 1907. No. 85195 C.

Cement.

Cement for Building Construction. Report of the Committee of the National Fire Protection Association. 5500 w. Eng Rec—June 8, 1907. No. 84856.

A Review of the Chemistry of Portland Cement. F. H. Mason. Outlines the method of manufacture, and reviews the researches of M. Le Chatelier in regard to the setting and hardening of cement. 2000 w. Min & Sci Pr—June 8, 1907. No. 84864.

Recommendations for the Uniform Supply and Testing of Portland Cement (Bestimmungen für die Einheitliche Lieferung und Prüfung von Portland-Zement). Report of a Committee of the Austrian Society of Engineers and Architects, giving recommendations for standard sizes and weights of packages and tests. 3000 w. Zeitschr d Oest Ing u Arch Ver—May 17, 1907. No. 84973 D.

Concrete Pipes.

Processes and Machines for the Production of Reinforced-Cement Poles and Pipes (Verfahren und Maschine zur Erzeugung von Armierten Zement-Masten und -Röhren). Hans Siegwart. Ills. Serial. 1st part. 1400 w. Beton u Eisen—May, 1907. No. 84955 F.

Fire Protection.

Concrete and Reinforced Concrete Construction from the Fire Protection View. Report of the Committee on "Cement for Building Construction" of the Nat. Fire Protection Assn. 4000 w. Eng News—June 6, 1907. No. 84817.

Hydraulic Cements.

The Hardening Process in Hydraulic Cements (Ueber die Erhärtungsprozesz der Hydraulischen Bindemittel). Dr. Rohland-Stuttgart. Treats the subject from the standpoint of physical chemistry. 2800 w. Stahl u Eisen—May 8, 1907. No. 84938 D.

Reinforced Concrete.

The Corrosion of Steel in Reinforced Cinder Concrete. William H. Fox. A report of experiments with a statement of conclusions. 1500 w. Eng News—May 23, 1907. No. 84859.

Statical Investigation of a Constantly-Recurring Problem in Reinforced-Concrete Construction (Statische Untersuchung einiger im Eisenbetonbau häufig Vorkommenden Aufgaben). Charles Abeles. Mathematical paper on the strength of reinforced-concrete beams. Serial. 1st part. 2000 w. Beton u Eisen—May, 1907. No. 84956 F.

Silt.

The Applicability to India of the Italian Method of Utilizing Silt. Sir Edward Charles Buck. Explains what India has done to utilize silt, and describes what Italy has done, suggesting further possibilities for India. 13500 w. Jour Soc of Arts—May 31, 1907. No. 84869 A.

Slag Cement.

Recommendations for the Uniform Supply and Testing of Slag Cement (Bestimmungen für die Einheitliche Lieferung und Prüfung von Schlacken-Zement). Report of a Committee of the Austrian Society of Engineers and Architects, giving recommendations for standard sizes and weights of packages and tests. 3000 w. Zeitschr d Oest Ing u Arch Ver—May 24, 1907. No. 84074 D.

Specifications.

Concerning Bridge Steel and Ship Steel. Editorial urging the unification of specifications for structural steel. 1000 w. Eng News—June 6, 1907. No. 84818.

MEASUREMENT.

Beams.

The Point of Economy in the Design of Reinforced-Concrete Beams. Editorial on the paper of F. W. Hanna, and letter by P. L. Reed, with curves and discussion with conclusions. 3500 w. Eng News—June 20, 1907. No. 85158.

Bending Moments.

Analytical Investigation of the Maximum Bending Moment in Steel Bridges (Investigaciones Analiticas sobre el Momento Máximo de Flexión en Puentes Ferroviarios). C. W. Ljungstedt. Mathematical paper with diagrams. Serial. 1st part. 3000 w. Ingenieria—April 15, 1907. No. 84928 D.

Moving Loads on Railway Under-Bridges. H. Bamford. Considers analytical versus graphical methods of determining the maximum bending moment and shear due to a train-load. 2500 w. Engng—May 31, 1907. No. 84890 A.

Cantilevers.

Influence Lines for Suspended Cantilevers. Myron S. Falk. General deductions as to the determination of the statical condition of such structures, and the application of influence lines to determine the maximum stresses. 3000 w. Sch of Mines Qr—April, 1907. No. 85020 D.

Centre of Gravity.

Investigation of More General Formulæ for Centres of Gravity and Moments of Inertia (Indicación de una Fórmula la más General para los C de G; para los M de I). J. Galí. Mathematical paper illustrated by diagrams. 7000 w. Revista Tech Ind—April, 1907. No. 84929 D.

Leveling.

Precision Leveling in the Argentine Republic (La Nivelación de Precisión en la República Argentina). Arduino Lelli. Reviews the history of precision leveling and discusses the theory, errors, results obtained in Argentina, etc. Serial. 3 parts. 20000 w. Anal Sociedad Cien Argen—Sept., Oct., and Nov., 1906. No. 84931 each F.

Recording Extensometer.

An Extensometer for Recording Deformations in Bridge Members Under Impact Stress. Illustrated detailed description of an autographic instrument devised by F. E. Turneaure. 1200 w. Eng News—June 20, 1907. No. 85155.

Surveying.

Difficulties Encountered in Early Surveys of the State of Massachusetts; How They Were Overcome and the Results Obtained. Frank W. Hodgdon. 5000 w. Jour Assn of Engng Socs—May, 1907. No. 85143 C.

Photographic Surveying. William Griffith. An illustrated explanation of a method of making topographic surveys and maps of a region from a series of photographs. 1000 w. Mines and Min—June, 1907. No. 84739 C.

Two-Hinged Arches.

The Two-Hinged Arch with Tie Rod (Der Zweigelenkbogen mit Zugband in Beliebiger Höhe). F. Bohny. An elaborate, mathematical analysis of the stresses in this type of truss. Ills. 10000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—No. 84978 D.

MUNICIPAL.

Fire Protection.

Fires in Cotton-Mills; Their Prevention and Extinction. The causes of fires are considered and suggestions for fire fighting. Ills. 2000 w. Engng—May 31, 1907. No. 84891 A.

Pavements.

Brick Pavements. Presents some of the advantages of brick pavements and gives illustrations of streets in various cities. 1300 w. Munic Engng—June, 1907. No. 85178 C.

Recent Progress in the Asphalt Paving Industry. Abstract of a recent paper by Clifford Richardson, reviewing the development of sheet asphalt paving, and discussing the principles upon which good construction is based, the materials, and recent improvements. 5700 w. Eng Rec—June 1, 1907. No. 84701.

Tar Macadam Pavement in Duluth, Minn. E. K. Coe. A description of the methods used, and report of the satisfactory results. 2800 w. Eng News—May 30, 1907. No. 84697.

The Development of Street Pavements. George W. Tillson. A study of the causes that led to the use of the different materials and the changes adopted. Ills. 5000 w. Jour Fr Inst—June, 1907. No. 85138 D.

How to Compute the Cross-Section of a Curved Street Paving. Analysis and practical application of method. 500 w. Engng-Con—June 12, 1907. No. 85034.

Public Health.

The Spreading of Diseases by Insects and Their Extermination (Die Uebertragung von Krankheiten durch Insekten und ihre Bekämpfung). Claus Schilling. 3000 w. Gesundheits-Ing—May 11, 1907. No. 84969 D.

Refuse Disposal.

English, German, and Swiss Destructor

Plants. Frank C. Perkins. An illustrated article describing these plants and the use made of the power. 2500 w. Munic Engng—June, 1907. No. 85177 C.

Disposal of House Refuse. Illustration and description of the "Lightning" refuse disintegrator, its operation and cost of treatment. 800 w. Engng—June 7, 1907. No. 85117 A.

Roads.

Tar-Spreading Tests. Reports a series of tests of machines designed for this work to determine their efficiency and cost of operation. Ills. 3000 w. Engr, Lond—May 4, 1907. No. 84761 A.

The Dust Prevention Competition. A report of the practical tests in England of roads treated by tar-spraying machines, and of the competing machines. Ills. 2500 w. Autocar—June 1, 1907. No. 84873 A.

Sewage.

The Comparative Disposition of Organic Matter by Sand, Contact and Sprinkling Filters. H. W. Clark. Abstract of a paper read before the Am. Pub. Health Assn., City of Mexico. A study of the organic matter in suspension in sewage. 4500 w. Eng News—June 6, 1907. No. 84813.

Hanley Sewage Works. Gives an outline of recently completed works said to be the most perfect sewage scheme ever put in operation. 1500 w. Engr, Lond—May 31, 1907. No. 85001 A.

Sewers.

Cost of Trenching, Pipe-laying and Backfilling for Sanitary Sewer Construction at Centerville, Iowa. Gives table showing the man hours and unit cost for each job separately. 1200 w. Engng-Con—June 12, 1907. No. 85035.

WATER SUPPLY.

Bore Holes.

Determining the Direction of Deep Bore Holes and Testing Their Water Tightness. Illustrates and describes an instrument devised by John J. Horan for use in connection with the work of building the great aqueduct that is to carry additional water to New York City. 800 w. Eng News—May 23, 1907. No. 84858.

Dam.

Cataract Dam, New South Wales. Brief illustrated description of the largest dam in Australia. 2500 w. Aust Min Stand—May 1, 1907. No. 84870 B.

Filtration.

Modern Tendencies in Filtration. George C. Whipple. Brief consideration of the latest theories, sand filters, mechanical filters, preliminary treatment, etc. 18000 w. Munic Jour & Engr—June 5, 1907. No. 84768 C.

The Filtration of Water at Bolton. L. Mitchell. General remarks on the progress of filtration methods and the efficiency of slow sand filters, with illustrated description of the mechanical filters at the Bolton water-works, stating their advantages. 4000 w. Engng—June 7, 1907. No. 85112 A.

The Slow-Sand Filtration Plant and Other Water-Works Improvements at Denver, Colorado. Illustrates and describes important changes recently made to the system, including three new filters, a system of underground wooden galleries, pumping plant, etc. 3000 w. Eng Rec—June 22, 1907. No. 85204.

The Water Filtration Plant at Moline, Ill. Illustrated description of a plant with a normal capacity of 5,000,000 gal. in 24 hours. 4800 w. Eng Rec—June 15, 1907. No. 85058.

Irrigation.

Irrigation Colonies in India. Laurence Robertson. Deals especially with the methods adopted for peopling these tracts. Discussion. 13800 w. Jour Soc of Arts—June 14, 1907. No. 85232 A.

Mains.

Testing with a Scraper for Obstructions in a Long Water Main. Extract from a paper by R. H. Dorman, describing the passing of a scraper through the whole length of a pipe laid in Ireland, to make sure that no obstructions existed which might interfere with the flow. 1500 w. Eng News—May 30, 1907. No. 84698.

Massachusetts.

The Metropolitan Water-Works System of Massachusetts. Caleb Mills Saville. Reviews the history, giving an account of the organization and description of the works. 2500 w. Munic Engng—June, 1907. No. 85175 C.

Pollution.

The Detection of Pollution in Underground Waters, and Methods of Tracing the Source Thereof. John C. Thresh. Before the Assn. of Water Engrs. Reports utility tests made by the use of salt, fluorescin, and other substances. 5000 w. Engr, Lond—June 14, 1907. No. 85249 A.

Some Relations of Stream Pollution and Water Purification. Charles Carroll Brown. Discusses the problems of stream pollution and the legal limitations; the legislation in various countries, and various parts of the United States; the damage to water supplies; the sources of water supply and the purification of water, etc. 9000 w. Wis Engr—June, 1907. No. 85128 D.

The Work of the Ohio State Board of Health on Water Supply and Sewage Disposal. R. Winthrop Pratt. An outline of the work in connection with pollution, its prevention and rectification. 2800 w. Eng News—June 20, 1907. No. 85154.

Pumping Engines.

See Mechanical Engineering, Hydraulics.

Pumping Stations.

The Pelham Pumping Station of the New Rochelle Water Co. Illustrated description of a small station to supplement a gravity supply. 1200 w. Eng Rec—June 15, 1907. No. 85059.

High-Pressure Fire-Service Pumping Station at Coney Island. B. Franklin Hart, Jr. Illustration, with description of the station and report of tests. 2000 w. Stevens Ind—April, 1907. No. 85124 D.

Rates.

Rates for Water Service. Dabney H. Maury. Presidential address before the Am. Water-Works Assn. Outlines the principles which should govern the determination of the fair rate. 1500 w. Eng. News—June 27, 1907. No. 85301.

Reservoirs.

The Settling Reservoirs of the New Cincinnati Water-Works. William C. Jewett. Illustrated detailed description of the construction of these reservoirs. 2500 w. Eng Rec—June 8, 1907. No. 84850.

Sluicing Gates.

Large Electrically Operated Gates for the Roosevelt Dam, U. S. Reclamation Service. F. W. Hanna. Illustrated detailed description of the gates to be installed, which are the largest in the world operated under the pressure to which they will be subjected. 2700 w. Eng News—May 30, 1907. No. 84696.

Wells.

Water Supplies by Means of Artesian Bored Tube-Wells. Herbert F. Broadhurst. Read before the Inst. of Min. Engrs. Describes methods used in boring artesian tube-wells, and for their protection, testing and pumping. 4000 w. Ir & Coal Trds Rev—June 14, 1907. No. 85251 A.

WATERWAYS AND HARBORS.

Canals.

The Somersetshire Coal Canal. Illustrates and describes this old canal in England. It is to become the site of a single line railway for the Great Western system. 1500 w. Engr, Lond—May 24, 1907. No. 84760 A.

Floods.

Flood Protection in Ithaca, N. Y. Describes conditions at this city on Cayuga Lake, and the means taken to confine Six Mile Creek to a safe channel. Ills. 2200 w. Eng Rec—June 8, 1907. No. 84855.

Mersey.

The Mersey Channel. Illustrated description of proposed work to deepen the entrance channel. 400 w. Engr, Lond —June 14, 1907. No. 85247 A.

Panama.

The Isthmian Canal—A General Résumé of the Work Accomplished. F. B. Maltby. 10500 w. Pro St Louis Ry Club —May 10, 1907. No. 85044.

The Panama Canal and Conditions in the Canal Zone. O. L. Whitelaw. Impressions from a trip to the isthmus. Ills. 5500 w. Pro St Louis Ry Club—May 10, 1907. No. 85045.

The Preparatory Period, Panama Canal. Gen. Henry L. Abbot. Gives a brief summary of events since the United States obtained control, and discusses matters of technical interest having a bearing upon the project. 3500 w. Harvard Engng Jour—June, 1907. No. 85191 D.

Paraná.

The Artificial Canalization of the Rio de la Plata (Canalización Artificial del Rio de la Plata). Augustin Mercau. A discussion of the project for a ship canal from Buenos Ayres to Paraná de las Palmas, giving costs, etc. Plate. 11000 w. Anal Sociedad Cien Argen—Dec., 1906. No. 84932 F.

Salton Sea.

Colorado River Crevasse and Salton Sea. H. T. Cory. An illustrated account principally devoted to the work of closing the second break. Especially considers the effect on the railway lines of the Southern Pacific. 2500 w. Ry Age—June 14, 1907. No. 85085.

Seville.

The Port of Seville. Mateo Clark. Reviews the history of this port and improvements made in the Guadalquiver River between Seville and the ocean, describing proposed new works. 2000 w. Engng—June 14, 1907. No. 85245 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

The Pupin Telephone Cable Across Lake Constance. Gives an account of the difficulties experienced in manufacturing and laying a cable with Pupin coils, and compares the results with ordinary telephone cables. 3000 w. Elect'n, Lond—May 24, 1907. No. 84753 A.

Printing Telegraphs.

Keyboard Page-Printing Telegraphs. Romyn Hitchcock. Discusses the advantages claimed for typewriter keyboard printers, considering especially the Rowland multiplex printing telegraph and the telegraphic typewriter invented by J. E. Wright. 2500 w. Elec Rev, N Y—June 1, 1907. No. 84716.

Radiotelegraphy.

An Ungrounded, Closed Circuit for Receiving Wireless Signals. Greenleaf W. Pickard. Describes an interesting system, giving some details of the method of adjusting it and some results of tests. 1200 w. Elec Rev, N Y—June 15, 1907. No. 85069.

Recent Contributions to Electric Wave Telegraphy. Prof. J. A. Fleming. Presented before the Roy. Inst. of Gt. Britain. The present number considers effects of electric wave telegraphy which can be measured. 3000 w. Elect'n, Lond —May 31, 1907. Serial. 1st part. No. 84887 A.

Recent Developments in Wireless Telegraphy. Dr. Lee de Forest. A brief review of the rapid development of this science, recent advances and problems yet to be solved. 3500 w. Jour Fr Inst—June, 1907. No. 85139 D.

The Commercial Future of Wireless Telegraphy. E. Millian Trinks. Considers in detail the factors affecting the ultimate commercial value. 1200 w. Elec Rev, N Y—June 1, 1907. No. 84714.

Sound.

Some Observations on Sound. George Sherwood Hodgins. A study of the degree of loudness and pitch of tones produced both mechanically and electrically. 2300 w. Ry & Loc Engng—June, 1907. No. 84776 C.

Telegraph Receiver.

The Creed Receiving Telegraph Perforator. A perforating receiver which has been in successful operation for two years is illustrated and described. 1200 w. Elec Rev, Lond—June 14, 1907. No. 85237 A.

Telegraphy.

Telegraph Switching: Metropolitan Intercommunication Scheme. An illustrated article discussing a system to meet the requirements of Greater London. 700 w. Elec Rev, Lond—May 24, 1907. Serial. 1st part. No. 84747 A.

Telephone Relays.

Telephone Relays (Le Relais Téléphonique). M. Henry. A review of the development of the telephone relay and a discussion of its present status. Ills. 3500 w. Soc Belge d'Electriciens—May, 1907. No. 84916 E.

Telephony.

Inductive Disturbances in Telephone Line. Louis Cohen. Discusses the question from a mathematical standpoint, showing that not only is the electromagnetic induction not a negligible quantity, but that in some cases its effect may be much larger than the electrostatic effect. Considers the results obtained by J. J. Carty. 2000 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85285 D.

DISTRIBUTION.

Dangers.

Hygienic Aspects of Interior Uses of Electricity (Zur Hygiene der Elektrischen Hauseinrichtungen). S. Jellinek. Discusses the various sources of danger in the use of electricity, giving numerous examples. 6000 w. Serial, 2 parts. Der Elektrotechniker—May 10 and 25, 1907. No. 84966 each D.

Losses.

An Analysis of the Distribution Losses in a Large Central Station System. Abstract of a paper by L. L. Elden, presented before the Boston branch of the Am. Inst. of Elec. Engrs. 2000 w. Elec Wld—June 22, 1907. No. 85227.

Theatres.

Rules Governing the Installation of Theatre Wiring. Gives the suggested "Special Rules and Requirements for the Installation of Wires and Apparatus for Electric Light, Heat and Power in Theatres Where Potential of System Does Not Exceed 250 Volts" as recommended by the committee appointed by the Nat. Bd. of Fire Underwriters. 2500 w. Elec Wld—June 8, 1907. No. 84846.

Wiring.

Wiring Plans for Heating Devices. F. M. Feiker. Briefly explains the three general plans in use for wiring houses, giving a résumé of the Nat. Elec. Code rules governing the installation of heating devices, and gives details of houses illustrating the different systems. Ills. 2000 w. Elec Rev, N Y—June 1, 1907. No. 84718.

DYNAMOS AND MOTORS.

Design.

The Mechanical Design of a Standard Line of Electric Motors. Hal Luckin. Enumerates the points which should not be overlooked. 2000 w. Elec Rev, Lond —May 24, 1907. No. 84749 A.

Induction Motors.

Polyphase Induction Motors. Robert D. Archibald. Abstract of a paper read before the Birmingham and District Electric Club. Describes the action, construction and possibilities of two- and three-phase induction motors. 3500 w. Elec Engr, Lond—May 24, 1907. No. 84746 A.

The Estimation of Starting Resistances for Three-Phase Induction Motors. D. A. Trickett. Describes the lines upon which the resistances of such machines may be estimated in design. 1200 w. Elec Rev, Lond—May 24, 1907. No. 84748 A.

Interpoles.

The Present State of Direct-Current Design as Influenced by Interpoles. F. Handley Page and Fielder J. Hiss. A statement of the present condition of direct-current design, showing how it has been affected by the interpole machine which ensures a more efficient ventilation, lower first cost due to saving in material, and improved efficiency. 8500 w. Inst of Elec Engrs—May 23, 1907. No. 85-036 N.

Single Phase.

The Vector Diagram of the Compensated Single-Phase Alternating-Current Motor. W. I. Slichter. An analysis of the character and cause of the reactions effecting the efficiency and power-factor. 1000 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85284 D.

The Construction and Application of the Serviceable Single-Phase Motor (Die Bauart und Verwendung der praktisch Brauchbaren Einphasen-Wechselstrommotoren). A. Linker. Ills. Serial. 2 parts. 5000 w. Elektrotech u Polytech Rundschau—May 8 and 15, 1907. No. 84951 each D.

Speed Regulation.

Notes on Speed Regulation of Direct-Current Motors Under Different Conditions of Working. J. W. Rogers. A brief review of the methods used in present-day practice to obtain variations in speed over a wide range, without detracting from the efficiency of the system. Serial. 1st part. 2300 w. Prac Engr—June 7, 1907. No. 85095 A.

Motor Control. Describes a patent granted to V. A. Fynn relating to means for operating single-phase motors having a shunt characteristic at any desired speed independently of the periodicity of the supply and the number of poles of the motor. 700 w. Elec Engr, Lond—June 7, 1907. No. 85100 A.

Synchronous Motors.

Synchronous Motor Problems. H. H. Norris. Gives a study of the Metropolitan Alternator in the power house of the New York City Railway Co. 1700 w. Sib Jour of Engng—June, 1907. No. 85135 C.

Turbo-Alternator.

Willans-Dick-Kerr 2000-KW. Turbo-Alternator for Sydney. Illustrated detailed description of both the turbine and alternator. 3000 w. Elec Engr, Lond—June 7, 1907. No. 85098 A.

ELECTRO-CHEMISTRY.

Alkali Works.

The New Electrolytic Alkali Works at Niagara Falls. Extracts from a paper by Dr. L. H. Backeland on the Townsend cell, which has been in successful use for a year in Niagara Falls. Also editorial. Ills. 3000 w. Elec-Chem & Met Ind—June, 1907. No. 84778 C.

Electric Furnace.

The Economic Status of the Electric Furnace. Wilder D. Bancroft. Considers some of the advantages of the electric furnace, the nature of the competition it has to face, the products manufactured, illustrating points in which electricity is superior to other forms of heating. 2000 w. Sib Jour of Engng—June, 1907. No. 85136 C.

Electro-Plating.

Electro Deposition of Brass. Charles H. Proctor. Read before the Am. Found. Assn. Suggestions for producing deposits of alloys. 1000 w. Ir Age—June 6, 1907. No. 84734.

Nitric Acid.

The Electrochemical Production of Nitric Acid from the Air (La Fabrication Electrochimique de l'Acide Nitrique à l'Aide des Eléments de l'Air). Jean Escard. A review of the investigations on this subject with descriptions of the processes employed. Ills. 8000 w. Soc Belge d'Electriciens—May, 1907. No. 84915 E.

Ozone.

Industrial Application of the Electrical Discharge (Aplicación Industrial del Efluvio Eléctrico). F. M. Fernández. Discusses the various applications of ozone in the purification of water, in chemistry and in the sugar industry. Ills. 5000 w. Energia Eléctrica—May 25, 1907. No. 84927 D.

Storage Batteries.

Storage Batteries. V. Karapetoff. Explains tne properties of storage batteries and the advantages from their use. Describes their construction and chemical action, and method of testing. Ills. 2800 w. Elec Jour—June, 1907. Serial. 1st part. No. 85131.

ELECTRO-PHYSICS.

Electrons.

The Properties of Electrons. Samuel Sheldon. Presidential address. An explanation of electrons and their physical properties, and their effects when in motion. 8000 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85276 D.

Electrons (Sur les Electrons). H. Becquerel. Mathematical and theoretical discussion of the electron theory, reviewing the work of the leading investigators of the subject. Ills. 5600 w. Bull Soc In d' Electriciens—May, 1907. No. 84,-913 F.

Electrons (Los Electrones). Julio J. Gatti. A general review of the electron theory. 9000 w. Anal Sociedad Cien Argen—Aug., 1906. No. 84930 F.

Magnetism.

Critical and Supplementary Notes on the Theory of the Magnetism of Iron (Kritische Betrachtungen und Ergänzungen zur Theorie des Ferromagnetismus). R. Gans. Theoretical and mathematical discussion of the accepted formulæ. Diagrams. 5500 w. Elektrotech Zeitschr—May 23, 1907. No. 84987 B.

On the Law of Magnetic Attraction at a Distance and Its Applications (Loi d'Attraction Magnétique à Distance et ses Applications). R. V. Picou. A theoretical, mathematical discussion with examples showing the importance of further knowledge. Ills. 3500 w. Bull Soc Int d'Electriciens—May, 1907. No. 84914 F.

Resistance.

The Variation of Manganin Resistance with Atmospheric Humidity. E. B. Rosa and H. D. Babcock. Read before the Am. Phys. Soc. It has been noticed that manganin resistances change their value regularly with the time of year. Shows that this change is due to variations of humidity. 2800 w. Elect'n, Lond—June 14, 1907. No. 85240 A.

Wave Distortion.

Distortion of Alternating - Current Waves due to the Presence of Iron (Deformazioni d'Ouda delle Correnti Alternate per la Presenza del Ferro). Theoretical discussion illustrated by numerous curves. 1500 w. L'Elettricità—May 24, 1907. No. 84921 D.

GENERATING STATIONS.

Balancers.

Static Balancers. Charles C. Garrard. Gives a general description of the apparatus with a diagram illustrating the system, discussing it in detail, and describing its advantages. 2300 w. Elec Rev, Lond—June 14, 1907. Serial. 1st part. No. 85239 A.

Coal Handling.

Coal Handling and Condensing Equipment in the Gold Street Station of the Edison Electric Illuminating Company of Brooklyn. An illustrated description of the condensing apparatus and coal and ash handling machinery. 3500 w. Elec Wld—June 15, 1907. No. 85071.

England.

The Windsor, Slough, and Datchet Electricity Supply Undertakings. Reviews the main features of the undertakings, describing the machinery used in the different stations, and showing the progress. 1000 w. Elec Engr. Lond—June 7, 1907. Serial. 1st part. No. 85099 A.

Government Buildings.

Electricity in the Government Buildings in Washington, D. C. Illustrated description of the present electrical equipments of the government buildings and the uses to which electricity is applied, with an account of a proposed central station to supply current. 5000 w. Elec Wld—June 8, 1907. No. 84847.

New Power Plant for Legislative Group of Buildings in Washington, D. C. Short illustrated description of a central plant to supply electricity for a group of buildings on Capitol Hill. 1000 w. Elec Wld—June 1, 1907. No. 84848.

Hydro-Electric.

The Development of the McCall's Ferry Power Company. Day Allen Willey. An illustrated outline of this project for utilizing the water of the Susquehanna River. The dam under construction is one of the most extensive in the world. 2000 w. Elec Rev, N Y—June 1, 1907. No. 84717.

The Hydro-Electric Plant at Trezzo d'Adda (L'Impianto Idroelettrico di Trezdo d'Adda). An illustrated description of one of the largest Italian plants. 1500 w. L'Elettricità—May 10, 1907. No. 84919 D.

The Generating Station at Beznau, Switzerland (Usine Electrique de la Beznau, Suisse). P. Chignaterie. An illustrated description of the hydraulic, steam and electrical equipment of this hydroelectric plant on the Aar which has a subsidiary steam-turbine installation. 2000 w. Génie Civil—May 4, 1907. No. 84906 D.

Municipal Plant.

The Cleveland Municipal Electric Lighting Plant. Illustrated detailed description of a new plant in service since March. 1500 w. Elec Rev, N Y—June 15, 1907. No. 85070.

Portland, Ore.

The Water and Electric Power Systems of the Portland Railway Light and Power Company, Portland, Oregon. W. P. Hardesty. An illustrated article describing briefly the older portions of this system, and in detail, the latest addition. 7000 w. Eng News—June 27, 1907. No. 85200.

Rates.

The Principles of Modern Rate-Making for Electric Light and Power. Gives an analysis of the cost of supplying different classes of business, and explains several systems in use. 6000 w. Elec Wld—June 1, 1907. No. 84723.

Methods of Computing Central Station Rates in Boston. An explanation of the method of computing rates used by the Edison Electric Illuminating Company. 2000 w. Elec Wld—June 1, 1907. No. 84724.

The Present Tendency of Charging for Electricity. W. A. Toppin. Remarks on the many changes being made in the system of charging in English towns, and suggests that an effort be made to secure uniformity. 1500 w. Elec Rev, Lond—June 7, 1907. No. 85104 A.

Safety.

Security from Fire and Danger to Life in Electrical Plants (Die Sicherheit Elektrischer Anlagen bezüglich Feuer und Leben). G. Dettmar. Conclusions based on the experiences of German fire-insurance companies. Tables. 4400 w. Elektrotech Zeitschr—May 30, 1907. No. 84988 B.

Transformers.

Protection of the Internal Insulation of a Static Transformer Against High-Frequency Strains. Walter S. Moody. Introductory to a general discussion. Explains how a theory that very little preventive reactance is necessary to protect the winding of a transformer whose outer turns are heavily insulated has been carried out and tested on a large scale. Ills. 1000 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85278 D.

Choke-Coils versus Extra Insulation on the End-Windings of Transformers. S. M. Kintner. Introductory to a general discussion. States the advantages and disadvantages of separate choke-coils. 1200 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85277 D.

United States.

Central Stations in the United States (Elektrische Centralen in de Vereenigde Staten). Th. E. Maltha. Describes several large steam-driven power plants in and about New York, Boston and Chicago, giving details of equipment. Ills. 9000 w. De Ingenieur—May 25, 1907. No. 84992 D.

Washington, D. C.

Electricity in Washington, D. C., and Its Environs. An illustrated outline of some of the more important electrical developments. 2000 w. Elec Rev, N Y—June 1, 1907. No. 84713.

Generating Stations and Sub-Stations of the Potomac Electric Power Company, Washington, D. C. An illustrated historical review of electric lighting at the capital of the United States, describing the present stations. 7000 w. Elec Wld—June 1, 1907. No. 84721.

LIGHTING.

Arc Lamps.

New Developments in Arc Lamps and High-Efficiency Electrodes. George M. Little. Read before the Nat. Elec. Lgt. Assn. Deals with magnetite electrodes and a lamp suitable for using them. 2500 w. Elec Rev, N Y—June 15, 1907. No. 85068.

The Beck Flame Arc Lamp. Illustrated description of an arc lamp in which the carbons descend by gravity as they are consumed. 1500 w. Elec Engr, Lond—May 24, 1907. No. 84745 A.

Exposition.

Lighting of the Jamestown Ter-Centennial Exposition. An illustrated description of the lighting of the exhibition buildings and grounds. Also of the electric service plant. 2000 w. Elec Wld—June 1, 1907. No. 84722.

Filaments.

The Temperature and Emissivity of Carbon, Osmium, and Tungsten Filaments. A. Grau. Abstract translation from *Elektrotechnic und Maschinenbau.* A report of experimental investigations. 1200 w. Elect'n, Lond—June 7, 1907. No. 85107 A.

Mercury Vapor.

The Mercury Vapor Lamp (La Lampe à Vapeur de Mercure). M. de Recklinghausen. Gives a sketch of the development of the Cooper-Hewitt lamp, describes its construction and operation, and compares it with other types of lamps. Ills. 3700 w. Bull Soc d'Encour—April, 1907. No. 84900 G.

Problems.

The Problem of Illumination. Joseph H. Hart. Briefly considers the problems of light production. 2000 w. Cassier's Mag—June, 1907. No. 85180 B.

Wind Power.

Domestic Electric Light Plant Driven by a Windmill. Illustrations, with short description of a successful plant at Noblesville, Ind. 400 w. Sci Am—June 1, 1907. No. 84673.

MEASUREMENT.

Capacity.

Measurement of the Resistance of Insulation and the Capacity of the Separate Wires of an Alternating-Current Circuit during Working (Messung des Isolationswiderstandes und der Kapazität der Einzelnen Leiter von Wechselstrom-Anlagen während des Betriebes). Johann Sahulka. Diagrams. 6000 w. Serial. 2 parts. Elektrotech Zeitschr—May 2 and 9, 1907. No. 84985 each B.

Electrical Units.

Electrical Laws and Units. Explains the meaning of the fundamental electrical units in common use. 1000 w. Ry & Loc Engng—June, 1907. No. 84775 C.

Illumination.

Measurement of Instantaneous Values of Electric Lights on Alternate Current. Dr. Johann Sahulka. Abstracted from *Elektrotechnik und Maschinenbau.* Describes methods proposed by the writer, and apparatus used. 1500 w. Elect'n, Lond—May 31, 1907. No. 84886 A.

On the Determination of the Mean Horizontal Intensity of Incandescent Lamps. Edward P. Hyde and F. E. Cady. Discusses the error due to flicker in lamp testing, giving recent investigations, the methods and results. 4000 w. Elec Wld—June 22, 1907. No. 85226.

Insulators.

A Test of Insulators for an Exceptional Service. Sidney Sprout. States the exceptional conditions to be met, describing the testing and giving results. Ills. 2500 w. Elec Ry Rev—June 15, 1907. No. 85079.

Leakage.

Simple Zero Methods for the Direct Determination of Leakage Factors. Dr. R. Pohl. Considers simple direct methods, referring to R. Goldschmidt's method, and two methods which give accurate results, and can be used with ordinary testing instruments. 1600 w. Elect'n, Lond—May 24, 1907. No. 84751 A.

Meters.

A New Type of Graphic Recording Meters. H. W. Young. Illustrates and describes a new type of meter which makes a record on a continuous roll of paper ruled with rectangular co-ordinates. 2500 w. Elec Rev, N Y—June 1, 1907. No. 84719.

Motor Testing.

Economical Testing of Generators and Motors. J. Lewis Cook. Briefly considers methods of testing D. C. machines in which the power developed by the machine under test is partly used to drive it. 1500 w. Elec Rev, Lond—June 7, 1907. No. 85102 A.

Oscillograph.

On Recording Transitory Electrical Phenomena by the Oscillograph. J. T. Morris. Describes the writer's use of the falling plate type of oscillograph. Diagrams. 1500 w. Elect'n, Lond—June 7, 1907. No. 85105 A.

Photometry.

The Speed of Flicker Photometers. J. S. Dow. Investigates the connection between the sensitiveness of a flicker photometer and the speed at which the flicker disc is driven. 1800 w. Elect'n, Lond—May 31, 1907. No. 84884 A.

Testing Plant.

The Arrangements of the Testing Station at Frankfurt (Die Einrichtungen des Elektrischen Prüfamtes in Frankfurt). Rudolf Kopp. Describes an elaborate plant for the testing of electric machinery and apparatus. Ills. 7000 w. Serial. 2 parts. Elektrotech Zeitschr—May 16 and 23, 1907. No. 84986 each B.

Transformer Testing.

Loading Stationary Induction Apparatus for Heat Tests. George C. Shaad. Describes testing transformers in pairs, and in threes, testing feeder regulators, and induction regulators. Diagrams. 1200 w. Elec Jour—June, 1907. No. 85132.

Wattmeters.

Hot-Wire Wattmeters and Oscillographs. J. T. Irwin. Describes a new type of polarized hot-wire instrument invented by the author, and some of the uses to which it can be applied. 7500 w. Inst of Elec Engrs—May 23, 1907. No. 85037 N.

TRANSMISSION.

Direct Current.

High-Pressure D. C. Transmission. Calls attention to some things to be considered in connection with the series system of direct-current power transmission. 1600 w. Elec Rev, Lond—June 7, 1907. No. 85103 A.

Economics.

Some Power Transmission Economics. Frank G. Baum. Illustrates and describes examples of line and switch construction to show that the best solution of a problem is the one which accomplishes the purpose satisfactorily with the least amount of money, on account of changes in design which become apparent as the industry develops. 1600 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85283 D.

Lightning Protection.

Lightning Rods and Grounded Cables as a Means of Protecting Transmission Lines Against Lightning. Norman Rowe. Introductory to a discussion. A summary of lightning troubles during the years 1904, 1905, and 1906, on a steel tower, long span transmission line in Mexico. Ills. 2200 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85280 D.

A Permanent-Leak Water Lightning Arrester. Lewis W. Dixon. Illustrated description of a water lightning arrester, recently erected in Wales. 700 w. Elect'n, Lond—May 24, 1907. No. 84752 A.

Line Troubles.

Location of Broken Insulators and Other Transmission Line Troubles. L. C. Nicholson. Introductory to a discussion. Explains a method of locating faults consisting of supplying current from a generator and transformer to the fault to earth through a divided circuit or a loop, formed by joining two line conductors together at both ends, one of the wires so connected containing the broken insulator to be located. Ills. 2700 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85281 D.

Single Phase.

One-Phase High-Tension Power Transmission. E. J. Young. Proposes a high-tension one-phase system having several desirable features not in common with either the direct-current or the three-phase system. 1500 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85282 D.

Spans.

Transmission Line Towers and Economical Spans. D. R. Scholes. Introductory to a general discussion. Describes a method by which the relation between the height, strength, and cost of a tower of given form may be expressed and its application to the problem of fixing the economical span for any given transmission line. 3300 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85279 D.

Wireless Energy.

The Operation of Mechanical Devices at a Distance by Means of the Wireless Transmission of Energy. Dr. Alfred Gradenwitz. Gives a brief review of the principles of wireless telegraphy and their application for the purpose of producing mechanical effects. Ills. 1500 w. Sci Am Sup—June 8, 1907. No. 84823.

MISCELLANY.

Insulating Materials.

The Manufacture of Electrical Porcelain. Dean Harvey. Illustrates and describes the process of manufacture. 1200 w. Elec Jour—June, 1907. No. 85133.

Phono-Cinematograph.

The Phono-Cinematograph (La Phono-Cinématographie). A. Bidault des Chaumes. Illustrated detailed description of apparatus for reproducing at the same time sounds by a phonograph arrangement and scenes by a cinematograph. 5000 w. Génie Civil—May 11, 1907. No. 84908 D.

INDUSTRIAL ECONOMY

Apprenticeship.

A Rational Apprentice System. An illustrated detailed description of the apprentice system recently introduced on the New York Central lines and being extended throughout the system. 7500 w. Am Engr & R R Jour—June, 1907. No. 84783 C.

Real Apprenticeship. G. M. Basford. Considers briefly some of the fundamental principles likely to lead to success. 1000 w. Am Engr & R R Jour—June, 1907. No. 84789 C.

Board of Trade.

British Board of Trade. A. R. Bell. An explanation of the powers and functions of this important organization. 2500 w. Ry & Loc Engng—June, 1907. No. 84773 C.

Contract Work.

The Responsibility of the Engineering Profession for the Conduct of Public Contracts. Major Cassius E. Gillette. Considers the processes of letting public contracts, and the duty of all honest engineers to follow such methods as will make fraud exceedingly difficult. 5000 w. Eng News—May 30, 1907. No. 84695.

Cost Keeping.

Expense: Man-Hour Distribution. F. E. Webner. The tenth of a series of articles on cost keeping. 1500 w. Ir Trd Rev—June 13, 1907. No. 85030.

Cost Accounts. H. F. J. Porter. Discusses the function of a cost accounting system and matters relating to such systems. 1800 w. Am Mach—Vol. 30, No. 26. No. 85297.

Machine-Shop Cost Estimating. George Bilham. Gives an analysis of the various factors, showing that there is too much addition for slide-rule computation. 1800 w. Am Mach—Vol. 30, No. 22. No. 84683.

Delivery.

How to Keep Promises of Delivery. J. Stratton. Gives details of a system adopted and found successful for insuring the fulfilment of promises of quick delivery of shop work. 1500 w. Elec Rev, Lond—June 14, 1907. No. 85238 A.

Education.

Lantern Slides for Shop Instruction. Charles A. Francis. Illustrated description of a method devised to teach Japanese workmen. Gives a set of slides showing mistakes made by workmen. 700 w. Am Mach—Vol. 30, No. 25. No. 85150.

Technical Training of Electrical Artisans. C. P. C. Cummins. Abstract of a paper before the Dublin Sec. of the Inst. of Elec. Engrs. Considers existing methods of training and the results, and a proposed system. Discussion. 3300 w. Elect'n, Lond—May 24, 1907. No. 84755 A.

The Technical Teaching of Electricity in France and in Foreign Countries (L'Enseignement Technique de l'Electricité en France et à l'Etranger). G. de Lamarcodie. Discusses equipment and teaching methods in a large number of European technical schools with especial reference to the more important French institutions. Ills. 8500 w. Revue Gen des Sci—May 30, 1907. No. 84905 D.

Some Recent Additions to the Technical Equipment of the Chemical Engineering Laboratories. Judson C. Dickerman. Describes machines recently added for work in industrial chemistry, and for technical gas analysis at the University of Wisconsin. Ills. 1000 w. Wis Engr—June, 1907. No. 85130 D.

Eight-Hour Day.

Report of the Miners' Eight Hour Day Inquiry Committee. Gives most of the important parts of this lengthy document which contains valuable information in regard to the economic conditions of the working of coal mines. Also editorial. 25000 w. Ir & Coal Trds Rev—May 24, 1907. Serial. 1st part. No. 84766 A.

Miners' Eight-Hour Day. Editorial discussion of the final opinion of the Committee appointed to inquire into the probable economic effect of a limit of eight-hours to the working-day of coal miners. 3000 w. Engng—May 31, 1907. No. 84894 A.

Engineering Building.

United Engineering Society Building. Description by the historical and publication press committee prepared for the dedication exercises of this building in New York City. Ills. 7000 w. Bul Am Inst of Min Engrs—May, 1907. No. 85268 C.

Engineering Ethics.

Proposed Code of Ethics. Gives the committee report of the Am. Inst. of Elec. Engrs. presenting a code of general principles of professional conduct for the guidance of the electrical engineer. 2000 w. Pro Am Inst of Elec Engrs—May, 1907. No. 85286 D.

Address by Arthur T. Hadley at the Dedication of the United Engineering Society Building in New York City. On what may be accomplished by engineers —his professional obligations. 2500 w. Bul Am Inst of Min Engrs—May, 1907. No. 85269.

Exhibition.

The Tokyo Industrial Exhibition. Charles A. Francis. An illustrated article outlining the purpose of the exhibition, the industries to be represented, and showing what has been done in a few months. 1200 w. Am Mach—Vol. 30, No. 24. No. 85010.

Financial Outlook.

Business and Finance in 1907; Retrospect and Prospect. Editorial discussion of the present condition in the security market, and the causes that can be looked for to change it. 2200 w. Eng News—June 27, 1907. No. 85302.

Foundry Management.

A System of Management in a Foundry. A brief account of the experience of a steel foundry with the task and bonus system. 1200 w. Ir Trd Rev—June 13, 1907. No. 85031.

Immigration.

The Italian on the Land: A Study in Immigration. Emily Fogg Meade. An account of the Italian population of Hammonton, N. J., showing how well they are adapted for agricultural pursuits, and giving much information in regard to their progress, industry, etc. 27000 w. Bul Bureau of Labor—May, 1907. No. 85262 N.

Labor.

The Labor Movement. Robert Gunn Davis. A psychological study, reviewing briefly the evolution and the social tendencies of trades unionism. Principally confined to conditions in England. 4500 w. Westminster Rev—June, 1907. No. 85259 D.

Labor Efficiency.

The Efficiency of the Worker and His Rate of Pay. Clive Hastings. Presents the advantages and disadvantages of the day rate, piece work and the bonus systems, with suggestions for determining a just wage. 3000 w. Am Engr & R R Jour—June, 1907. No. 84791 C.

The Methods of Exact Measurement Applied to Individual and Shop Efficiency at the Topeka Shops of the Santa Fe. Harrington Emerson. Describes the results accomplished at these shops, and the methods used. 3300 w. Am Engr & R R Jour—June, 1907. No. 84788 C.

Roundhouse Betterment Work. J. F. Whiteford. A description of a system of rewarding individual ability through increased pay as solved on the Santa Fe. 2200 w. Am Engr & R R Jour—June, 1907. No. 84786 C.

Labor Legislation.

A Short History of Labor Legislation in Great Britain. A. Maurice Low. Discusses principally factory conditions and legislation. 21500 w. Bul Bureau of Labor—May, 1907. No. 85263 N.

British Workmen's Compensation Acts. Launcelot Packer. A review of British legislation in regard to the compensation of workmen for injuries received in their employment, with full text of the Act of 1906, to take effect July 1, 1907. 29000 w. Bul Bureau of Labor—May, 1907. No. 85264 N.

Management.

Profit-Making in Shop and Factory Management. C. U. Carpenter. This sixth of a series of articles deals with methods for fixing standard times for manufacturing operations. 4500 w. Engineering Magazine—July, 1907. No. 85308 B.

Motive Power.

Statistics and Economic Importance of the Motive Power Problem (Statistique et Importance Economique de la Force Motrice Technique). C. Ballod. Discusses the importance of the motive power problem in relation to agriculture and industry and the status of gas motors, wind, water and sun power, with statistical information. 10000 w. Rev Econ Inter—May, 1907. No. 84012 H.

National Policy.

President Roosevelt Outlines His Railway Policy. Extracts from a speech delivered at Indianapolis outlining the national policy in reference to railways. Also editorial. 3000 w. Ry Age—June 7, 1907. No. 84830.

Open Shop.

The True Meaning of the Open Shop. James W. Van Cleave. An authoritative statement of the aims of the proposed educational campaign of the National Assn. of Manufacturers and the purpose in forming the federation and raising the fund for the work. 3000 w. Engineering Magazine—July, 1907. No. 85304 B.

Pacific Coast.

The Pacific Coast: An Inspiration to America. Albert Phenis. A review of the development and the causes of its prosperity. 5000 w. Mfrs Rec—June 27, 1907. Serial. 1st part. No. 85287.

Philippine Islands.

Engineering Works and Surveys in the Philippine Islands. G. R. Putnam. An outline of the progress in engineering works and surveys since the American occupation, describing the features of the islands of interest to engineers. 5000 w. Eng News—June 20, 1907. No. 85160.

Public Utilities.

The Public Utilities Law of New York. Editorial discussion of this law for the control of corporations which takes effect July 1st, 1907. 1700 w. Eng News—June 13, 1907. No. 85028.

The Public Utilities Bill. Full copy of the bill recently passed by the New York legislature, providing for regulation of railroads and public service companies. Also editorial. 20000 w. R R Gaz—May 31, 1907. No. 84670.

Securities.

Street Railway Securities—A Symposium. Contributions by Max Teichmann, Carl H. Nau, R. S. Buchanan, and editorial introduction by W. H. Lough, Jr. 3800 w. Jour of Acct—June, 1907. No. 85125 C.

Street Railway Bonds as Investments. Herbert G. Stockwell. A comparison with steam railroad bonds. 4500 w. Jour of Acct—June, 1907. No. 85126 C.

Stock Keeping.

A Stock Keeping System. Howard Hunt. Describes the system employed by the Cincinnati Planer Co. for ordinary stock supplies and keeping track of and distributing to the shop. 800 w. Ir Age —June 20, 1907. No. 85140.

U. S. Customs.

The United States Customs Service. Charles Leo Frank. Considers the organization and administration of that portion of the Customs Service which is directly concerned with the collection of duties on articles imported. 2200 w. Jour of Acct—June, 1907. No. 85127 C.

MARINE AND NAVAL ENGINEERING

Condensers.

Notes on Vacuum in Connection with Marine Machinery. H. C. Dinger. Discusses various matters that affect the vacuum, and how to get the most out of the condensing apparatus. 1500 w. Int Marine Engng—June, 1907. No. 84659 C.

Cruiser.

Launch of the New Scout Cruiser Birmingham. Illustrates and describes a new type of vessel for the U. S. Navy. 1500 w. Naut Gaz—June 6, 1907. No. 84835.

Derelict Destroyer.

New United States Derelict Destroyer. Illustrated description of the plans for the first derelict destroyer, Revenue Cutter No. 17, for which bids have been solicited. 1000 w. Marine Rev—June 6, 1907. No. 84825.

Destroyers.

The Ocean Race of Torpedo-Boat Destroyers. Brief account of the race over the 240-mile course from Sandy Hook to Cape Charles. Ills. 1000 w. Sci Am —June 15, 1907. No. 85014.

Dredge.

The Dredge "Independent." Illustrated detailed description of the 4½-yd. dipper dredge used constantly since 1906, in the extension of South Brooklyn docks. 1400 w. Eng Rec—June 1, 1907. No. 84700.

Dry Docks.

Floating Dry Dock No. IV at Rotterdam (Das Rotterdamer Schwimmdock IV). An illustrated detailed description of construction and operation. 2000 w. Elektrotech u Polytech Rundschau—May 1, 1907. No. 84950 D.

Gyrostat.

Practical Tests of the Schlick Gyrostat for Ships. Illustrated description of this apparatus for diminishing the rolling of ships, and of tests made. 1700 w. Sci Am—June 15, 1907. No. 85015.

Hydroplanes.

A Twelve-Foot Gliding Boat. Alfred E. Luders. Illustrates and describes a small hydroplane that may be built by an amateur. 3500 w. Rudder—June, 1907. No. 84731 C.

How to Build a Hydroplane Gliding Boat. William and Walter Stearns. Drawings and full directions. 1000 w. Sci Am Sup—June 15, 1907. No. 85016.

Inland Navigation.

Improvements Required in Inland Navigation. Henry Rodolph de Salis. Read before the Inst. of Min. Engrs. A discussion of the inland waterways of England and Wales. 3000 w. Ir & Coal Trds Rev—June 14, 1907. No. 85256 A.

Labrador Boats.

Eskimo and Indian Boats of Labrador. Stephen P. M. Tasker. Brief description of types of boats used along the coasts of Labrador, which differ but slightly from those used hundreds of years ago. 900 w. Int Marine Engng—June, 1907. No. 84660 C.

Magnetic Material.

On Some Experiments on the Magnetic Character of Vessels. Capt. W. Bartling. Read before the N. E. Coast Inst. of Engrs. and Shipbldrs. A report of observations made to obtain actual quantitative measurements of the effect of various influences on the standard compass. 1400 w. Elec Engr, Lond—May 31, 1907. No. 84880 A.

The Effect of Current Sheets on the Compass Needle on Board Iron Ships. C. Arldt. Trans. from *Elektrotechnische Zeitschrift.* A theoretical and experimental investigation. 1000 w. Elec Rev, Lond—May 31, 1907. No. 84881 A.

Propulsion.

The Del Proposto System of Electrical Transmission Gear for the Propulsion of Ships by Irreversible Engines. Describes an electrical method of power transmission in connection with the use of irreversible internal combustion engines for the propulsion of ships. 900 w. Sci Am Sup—June 22, 1907. No. 85164.

A New Method of Ship Propulsion (Een Nieuwe Wijze van Voortbeweging voor Stoomschepen). A. G. Bosman. Illustrates and describes a method of steamship propulsion by means of an endless chain of traveling buckets. 3000 w. De Ingenieur—May 18, 1907. No. 84991 D.

Signaling.

Submarine Signaling (Segnalazioni Sottomarine). Luigi Boggiano. A comprehensive review of the methods used and the results obtained from trials in various navies. Ills. 10000 w. Rivista Marittima—No. 84917 E + F.

Steamers.

The New Steamers Mexican and Columbian. Illustrates and describes two freighters, being built at San Francisco, and their equipment. 2500 w. Int Marine Engng—June, 1907. No. 84657 C.

The Pacific Twin-Screw Steamers "Quillota" and "Quilpue." Illustrated description of steamers intended for passenger and mail service on the west coast of South America. 1200 w. Engng—June 14, 1907. No. 85244 A.

Tank Steamer.

A Large Oil Steamer. Plans and description of the largest tank steamer ever built in the United States. The cargo oil capacity is 2,500,000 gallons. 3800 w. Int Marine Engng—June, 1907. No. 84661 C.

Torpedo Boats.

Notes on Motor Torpedo Launches. C. T. Brady, Jr. Discusses the advantages of the internal combustion engine for this service. Ills. 700 w. Int Marine Engng—June, 1907. No. 84658 C.

Oil-Fuel Turbine-Driven Torpedo-Boats. Illustrated descriptions of a new series of boats for the British Navy. 1500 w. Engng—May 24, 1907. No. 84757 A.

Turbines.

The Turbine Mail Steamer "Princesse Elisabeth" (La Malle-Poste à Turbines "Princesse Elisabeth"). E. and H. Comhaire. Describes the machinery and gives the results of tests of this steamer built for service between Dover and Ostende. Ills. 2500 w. Bull Sci d l'Assn des Elèves—April, 1907. No. 84904 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Bollee.

The 1907 Leon Bollée Cars. Illustrates one of the 4-cylinder live-axle models, and describes this car mainly, though referring to other types. 2000 w. Auto Jour—May 25, 1907. No. 84742 A.

Carburetter.

The Craven Carburetter. Illustrated description, with report of seven tests made. 1300 w. Autocar—June 15, 1907. No. 85233 A.

Car Fittings.

An Interesting Car and Its Refinements. Brief illustrated description of the equipment of Mr. Henry Edmund's Daimler. 1200 w. Auto Jour—May 25, 1907. No. 84743 A.

Commercial Vehicles.

The Stoltz Steam Tractor (Dampf-Lastwagen Bauart Stoltz). Herr Pflug. Illustrates and describes the boiler, engine, and construction details of this vehicle for heavy freight service. 3500 w.

Zeitschr d Mit Motorwagen Ver—May 15, 1907. No. 84948 D.

Patrol Lorry. Illustrated description of a motor wagon or lorry, for heavy hauling, made in Milwaukee, in which both axles are driven. 900 w. Engr, Lond—June 14, 1907. No. 85248 A.

Early Vehicles.

A Relic of Early Motor Vehicles. Frank C. Hudson. Illustration, with brief account of a self-propelled vehicle which made regular trips in 1834 in Scotland. 400 w. Am Mach—Vol. 30, No. 26. No. 85296.

Expositions.

The International Automobile Exposition in Berlin in the Autumn of 1906 (Die Internationale Automobilausstellung in Berlin, Herbst 1906). A. Heller. Illustrated detailed descriptions of the exhibits, the first part dealing with internal-combustion-motor cars. 4000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—May 18, 1907. No. 84982 D.

The First International Exposition of Commercial Automobiles in London, March, 1907 (Die erste Internationale Motorlastwagen-Ausstellung in London März 1907). Herbert Bauer. Illustrated detailed description of a large number of cars shown. 7000 w. Zeitschr d Mil Motorwagen Ver—April 30, 1907. No. 84946 D.

Ford.

The Ford Petrol Cars. Illustrates and describes these American-built cars, especially a 4-cylinder model. 700 w. Auto Jour—June 1, 1907. Serial. 1st part. No. 84875 A.

Gears.

The Chenard-Walcker Speed Gear. Illustrated description. 700 w. Autocar—June 15, 1907. No. 85234 A.

Martini.

The 40-50 H. P. Martini Car. Illustrated description. 1200 w. Autocar—June 1, 1907. No. 84874 A.

Motor Cooling.

The Anatomy and Pathology of Friction-Driven Pumps. Charles T. W. Hirsch. On this means of effecting water circulation for the prevention of overheating in automobiles and the difficulties. 1100 w. Motor Car Jour—June 15, 1907. No. 85231 A.

Motors.

Points of Resemblance and Difference in Our Automobile Motors (Aehnlichkeiten und Verschiedenheiten unserer Automobilemotoren). Ludwig von Löw. Compares several of the leading European types with regard to transmission, ignition, etc. Ills. 7000 w. Zeitschr d Mit Motorwagen Ver—May 15, 1907. No. 84947 D.

Omnibuses.

Petrol Motor Omnibuses. C. C. B. Morris. Abstract. Considers points in connection with the management and design of motor omnibuses. 2800 w. Prac Engr—May 31, 1907. No. 84878 A.

Omnibus Service.

The Present Cost of Motor Bus Services. Mr. Vellguth. Gives detailed information of results obtained by German and English companies. 12700 w. Bul Int Ry Cong—May, 1907. No. 85290 E.

Racing Track.

Brooklands Motor Track. A remarkable motor track nearing completion in England is illustrated and described. 2500 w. Auto Jour—June 1, 1907. No. 84876 A.

Spark Inductors

Theory and Design of Spark Inductors (Theorie und Vorausberechnung der Funkeninduktoren). E. W. Ehnert. The first part of the serial is devoted to a theoretical discussion of induction. Ills. Serial. 1st part. 3500 w. Elektrotech u Maschinenbau—May 5, 1907. No. 84975 D.

Speed Indicators.

Smith's Speed-Indicator Factory, Watford. Illustrates and describes these speed-indicators for motor-cars, and the factory where they are made. 1200 w. Engng—May 31, 1907. No. 84893 A.

Troubles.

General Pointers for the Novice Owner. Charles B. Hayward. Advice to beginners in driving automobiles, calling attention to troubles that are perplexing. 2500 w. Automobile—June 20, 1907. No. 85213.

COMBUSTION MOTORS.

Alcohol.

Alcohol for Power. John A. Secor. Reviews the present status of alcohol as a fuel for internal combustion engines. 4000 w. Mach, N Y—June, 1907. No. 84687 C.

Cylinders.

Stresses due to Heat in Hollow Cylinders (Temperaturspannungen in Hohlzylindern). Rudolph Lorenz. A mathematical discussion of the stresses in gas-engine cylinders due to unequal heating outside and inside. Diagrams. 4000 w. Zeitschr d Ver Deutscher Ing—May 11, 1907. No. 84981 D.

Diagrams.

Recreative Reading of Diagrams. L. Baudry de Saunier. Especially interprets the diagrams of automobile gas engines. 1500 w. Automobile—June 13, 1907. No. 85033.

Gas Engineering.

Gas Engineering. W. A. Baehr. Shows that a gas engineer needs to have civil, mechanical, electrical, and chemical knowledge. Considers the manufacture of artificial gases and their distribution. 8800 w. Jour Assn of Engng Socs—May, 1907. No. 85141 C.

Gas Engines.

History of the Progress of the Gas Engine. E. J. Williams. Reviews interesting inventions in this field since 1678, showing the development. 2500 w. Rudder—June, 1907. No. 84732 C.

A Historical Review of Gas-Engine Construction (Geschichtlicher Rückblick im Gasmotorenbau). A sketch of the development of the gas engine during the past fifty years. 2000 w. Elektrotech u Polytech Rundschau—May 22, 1907. No. 84952 D.

Gas-Engine Efficiencies. Leonard Bairstow. Considers methods of making the calculations, giving tables. 1400 w. Engng —June 7, 1907. No. 85111 A.

Working Experiences with Large Gas Engines. Cecil A. St. George Moore. Shows some of the defects which have presented themselves in actual work, and by what means and to what extent they have been overcome. 6500 w. Soc of Engrs—June 3, 1907. No. 85120 N.

How to Build a 5-Horse-Power Stationary Gas Engine. E. F. Lake. Drawings and directions. 3000 w. Sci Am Sup—June 15, 1907. Serial. 1st part. No. 85018.

600 B.H.P. Horizontal Twin Cylinder Gas Engine. Illustrates and describes a gas engine constructed for driving a ring spinning mill. 2200 w. Mech Engr —June 15, 1907. No. 85236 A.

1200-Horse-Power Gas Engine. Illustrated detailed description of a large engine running in the power house at Bargold, near Cardiff, which is driving an alternator in parallel with other engines. 600 w. Engr, Lond—May 24, 1907. No. 84762 A.

Gas Producers.

General Principles in the Construction of Modern Gas Producers. R. E. Mathot. Discusses the elements of producer design, considering, particularly, producers operated with anthracite, semi-anthracite, or coke. Ills. 5000 w. Engineering Magazine—July, 1907. No. 85306 B.

Recent Progress in Producer Gas Power Installations. Godfrey M. S. Tait. Illustrates and describes a producer gas installation in which variation in the gas is avoided so far as possible. 2000 w. Sci Am Sup—June 22, 1907. No. 85163.

Suction Producer Gas, Its Formation and Economy as a Means for Generating Power in the Modern Producer Gas Engine. J. H. Clapperton. Briefly considers the comparative efficiency of the steam and gas engine, giving a detailed account of what takes place in a gas producer. Ills. 3000 w. Cent Sta—June, 1907. No. 84712.

Producer Gas for Power. James A. Charter. Illustrated description of a suction gas producer and its operation, with general remarks. 2000 w. Ir Age—June 27, 1907. No. 85295.

Gas Producer for Pulverized Fuel (Gazogène à Combustible Pulvérisé). An illustrated description of the Marconnet producer which is charged continuously with pulverized fuel and which is said to utilize anthracite or bituminous coal, or even bituminous shale with equal facility. 1600 w. Génie Civil— May 11, 1907. No. 84909 D.

Gas Producers (Ueber Gasgeneratoren). Johannes Körting. A thorough review of the subject, describing the construction and operation of many types of producers and giving tables of the results obtained from them. Ill. Diagrams. and Tables. 14000 w. Stahl u Eisen—May 15, 1907. No. 84939 D.

Ignition.

Electric Ignition in Gas and Gasoline Engines (Noté sur l'Allumage Electrique des Moteurs à Gaz et à Pétrole). H. Lhonoré. The first part of the serial deals with low-tension ignition, illustrating and describing numerous types of magneto. 1200 w. Serial. 1st part. Revue de Méchanique—May 31, 1907. No. 84994 E + F.

Liquid Fuels.

Vaporization of Liquid Fuels. Charles Edward Lucke. Types of carbureters and vaporizers for gasoline, kerosene, and alcohol are illustrated and described. 4000 w. Engr, U S A--June 15, 1907. No. 85091 C.

Oil Engine.

The Cross Patent Heavy Oil Engine. Illustrated description of an engine designed for use with petroleum. 1600 w. Autocar—June 8, 1907. No. 85094 A.

HEATING AND COOLING.

Central Plants.

Warming and Ventilating the New Convocation Hall, University of Toronto. Charles L. Hubbard. A group of four buildings in course of construction to be warmed and lighted by a central plant. The system is illustrated and described. 2000 w. Eng Rec—June 15, 1907. No. 85062.

Hot-Water Heating of a Large Group of Buildings (Mitteilungen über die Beheizung einiger Gröszerer Gebäudegruppen with Warmwasser). A. C. Karsten. Illustrates and describes the heating systems of several groups of public buildings in Copenhagen. 2500 w. Gesundheits-Ing —May 25, 1907. No. 84971 D.

Combination Plants.

Heating and Ventilating. F. M. Griswold. Describes the fire hazard of combination systems, giving suggestions, and noting dangerous practices. 1800 w. Ins Engng—June, 1907. No. 85194 C.

Furnace.

Furnace Heating in an Allegheny Church. An interesting example of hot-air heating by the use of two furnaces in one battery, one furnace being equipped for burning coal, and the other for both coal or natural gas. 2000 w. Met Work—June 15, 1907. No 85038.

Hot Water.

The Heating of Water with Gas Fuel (Warmwasserversorgung mit Gasfeuerung). Paul Fusbahn. Illustrates and describes, in the first part of the serial, small bath-room installations for heating water as needed. Serial. 1st part. 4000 w. Gesundheits-Ing—May 11, 1907. No. 84968 D.

Office Building.

Heating and Ventilating the Title Guarantee Trust Building, New York. Plans and description of the systems installed. Ventilation is accomplished by both fresh air supply and exhaust. The heating is by direct radiation, utilizing exhaust steam. 4000 w. Eng Rec—June 1, 1907. No. 84702.

Refrigeration.

Mechanical Production of Low Temperatures. Sydney F. Walker. Discusses principles of refrigerating processes which may be used for cooling deep workings and in sinking by freezing. 4000 w. Eng & Min Jour—June 22. 1907. No. 85219.

Compression and Absorption Systems. Oswald Gueth. Gives considerations affecting the economy of the two systems and results from actual tests. 3300 w. Engr, U S A—June 15, 1907. No. 85089 C.

Combination Ice and Light Plants. Rufus E. Lee. Considers the cost of manufacturing ice in independent and combination plants. 3000 w. Ice & Refrig—June, 1907. No. 84728 C.

Steam Heating.

Comparative Cost of Steam Heating for Various Steam Pressure and Room Temperatures. John J. Harman. Gives information collected by the writer as to the amount of steam required in direct radiators for various steam pressures and room temperatures. 2000 w. Met Work—June 15, 1907. No. 85039.

Textile Mills.

A New Departure in Cooling and Humidifying Textile Mills. W. H. Carrier. Read before the Am. Assn. of Cotton Mfrs. Shows the Scientific principles applying to the artificial attainment of the conditions necessary in cotton mills, describing a system believed by the writer to embody such principles most effectually. 3300 w. Heat & Vent Mag—June, 1907. Serial. 1st part. No. 85266.

Theatre.

Construction and Operation of the Heating and Ventilating Arrangements of the New Theatre in Nürnberg (Bau und Betrieb der Heiz- und Lüftungseinrichtungen des Neuen Theatres in Nürnberg). O. Krell. An illustrated, detailed description. Serial. 2 parts. 22500 w. Gesundheits-Ing—May 18 and 25, 1907. No. 84970 D.

HYDRAULICS.

Canals.

The Effect of Changes in Canal Cross Sections Upon the Rate of Flow. F. W. Hanna. Gives briefly methods of determining mathematically the loss of head in canal flow due to contractions and expansions of cross section of waterway, either modified or unmodified. 2000 w. Eng News—June 6, 1907. No. 84820.

Centrifugal Pumps.

Various Types of Centrifugal Pumps and the Results of Tests (Verschillende Uitvoeringen en Beproevingsresultaten van Centrifugaalpompen met Vertikale Asopstelling). Chr. Feuwens. Gives tables of results of tests. Ills. 6000 w. De Ingenieur—May 18, 1907. No. 84990 D.

Recent Development and Future Application of Centrifugal Pumps. D. S. Brown. A comparison of centrifugal and reciprocating pump installations. 1800 w. Engr, U S A—June 15, 1907. No. 85090 C.

Kutter Formula.

Observations to Determine the Value of "C" and "N" as Used in the Kutter Formula. J. B. Lippincott. Describes methods of lining irrigating canals in California, and gives experiments made to study the working conditions of old lined canals to be used in connection with the designing of an aqueduct for the new water supply of Los Angeles. Ills. 2500 w. Eng News—June 6, 1907. No. 84815.

Piping.

A Study in Piping. William J. Splan. Gives detailed sketches and description of wrought-pipe drainage in the thirteen-story "DuPont" office building in Wilmington, Del. 1700 w. Dom Engng—June 15, 1907. No. 85067.

Pumping Engines.

High-Duty and Low-Duty Pumping Engines. From a paper by Irving H. Reynolds, before the Am. Water-Works Assn., regarding the points to be considered in making a choice between high-duty and low-duty types. 2500 w. Eng Rec—June 22, 1907. No. 85197.

Stream Flow.

Flood Flow in River Beds (Ueber das

Fortschreiten von Hochwasseranschwellungen in Fluszläufen). Philipp Forchheimer. Mathematical paper. Ills. 5500 w. Zeitschr d Oest Ing u Arch Ver—May 3, 1907. No. 84972 D.

MACHINE WORKS AND FOUNDRIES.

Bearings.

Spherical Bearings with Few Tools. M. R. Lathrop. An illustrated explanation of how a lathe and boring mill were rigged up to handle a difficult job and the good results that were obtained. 900 w. Am Mach—Vol. 30, No. 23. No. 84799.

Bells.

Bell Mixtures. On the manufacture of cast bells, the principal mixtures, methods, etc. Ills. 1200 w. Brass Wld—June, 1907. No. 85168.

Boiler Making.

Concerning Nipples in Sectional Boilers. Calls attention to the failure of nipples due to their not being adequately set and flared. Ills. 2500 w. Locomotive—April, 1907. No. 85257.

The Areas of Circular Segments. Gives approximate rules which give accurate enough results for general use, when the tables for computing such areas are not at hand. 3300 w. Locomotive—April, 1907. No. 85258.

Boring.

Boring Bars and Cutters. E. A. Dixie. Describes the methods used by the Link-Belt Company. Ills. 1400 w. Am Mach—Vol. 30, No. 25. No. 85151.

Brass Foundries.

Healthful Conditions in the Brass Foundry. Walter B. Snow. Read before the Am. Found. Assn. Describes installations for the removal of dust and fumes. 2000 w. Eng Rec—June 15, 1907. No. 85061.

Science Applied to the Brass Industry. Andrew M. Fairlie. Read before the Am. Found. Assn. Discusses the work of the chemist and metallurgist, the problems of electroplating and other work. 2200 w. Ir Age—June 13, 1907. No. 85005.

Brass Skimmings. Explains what skimmings are, the right method of treating them, assays, etc. 1500 w. Brass Wld—June, 1907. No. 85170.

Case-Hardening.

The Case-Hardening Furnace. J. F. Sallows. Considers its use for hardening, coloring and mottling. Ills. 1500 w. Mach, N Y—June, 1907. No. 84680 C.

Castings.

The Manufacture of Sandless Castings. John H. Shaw. Read before the Am. Found. Assn. Describes sandless molds and the method of operating, stating the uses to which they are best adapted. Ills. 900 w. Ir Age—May 30, 1907. No. 84667.

Compressed Air.

The Development of Compressed Air Tools (Die Entwicklung des Pressluftwerkzeugbaues). Alexander Lang. Illustrates and describes various types of compressed air hammers, drills, riveters, etc., built by the Porkorny and Wittekind Company of Frankfort. Serial. 1st part. 2500 w. Schiffbau—May 22, 1907. No. 84943 D.

Dies.

Novel Ideas in Die Making. Illustrates and describes practices of the Providence Mfg. & Tool Co. 4000 w. Mach, N Y—June, 1907. No. 84690 C.

Drawing Presses.

Making Seamless Steel Bath-tubs by Toggle Press Method. Illustrates and describes the equipment of the Pressed Steel Sanitary Co., Detroit. 1500 w. Met Work—June 1, 1907. No. 84672.

Drilling Machine.

Horizontal Drilling and Tapping Machine. Illustrated description of a large machine recently designed and built for high-speed work. 600 w. Engng—May 24, 1907. No. 84758 A.

Fire-Gilding.

Mercurial or Fire-Gilding and Its Production. Illustrated description of the first form of plating known. 2800 w. Brass Wld—June, 1907. No. 85169.

Forging Press.

Black Country Enterprise. J. Horton. Illustrates and describes the plant of Walter Somers & Co., Ltd., at Halesowen, Eng., which is adapted to the production of heavy work; especially describing a large forging press. 2000 w. Ir Trd Rev—June 13, 1907. No. 85029.

Gears.

A Comparison of the Efficiency of Two Trains of Spiral Gears. Gives in detail calculations for determining which is the better arrangement of two different sets of spiral gears for gas engines. Ills. 1600 w. Mach, N Y—June, 1907. No. 84691 C.

Gear Teeth.

A Standard for Short Involute Gear Teeth. Charles H. Logue. Considers the defects of the present system and presents a proposed system. 1800 w. Am Mach—Vol. 30, No. 23. No. 84796.

Hammers.

A Driving Mechanism for Percussion Machines. M. Ed. Sauvage. Trans. from *Bul. of Soc. d'Encour. pour l'Ind. Nat.* Illustrated description of a French invention in which a crank-driven hammer is free at the instant of striking. 1400 w. Am Mach—Vol. 30, No. 23. No. 84798.

Lathe.

The New Pratt & Whitney Turret Lathe. Illustrated description of an open turret lathe, designed for handling both bar stock and castings and performing a variety of work. 4500 w. Ir Age—June 27, 1907. No. 85292.

Machine Tools.

Recent French Machine Tools (Neuere Französische Arbeitsmaschinen). Illustrates and describes lathes, shears, planers, etc. Serial. 3 parts. 3000 w. Zeitschr f Werkzeugmasch u Werkzeuge—May 5, 15, and 25. No. 84967 each D.

Milling Machines.

Milling Machine Output. P. V. Vernon. Considers the conditions to be observed if the best output is to be obtained from any reasonably well designed machine. Ills. 3000 w. Engr, Lond—May 31, 1907. No. 84896 A.

The Brown & Sharpe No. 4-B Milling Machine. Illustrated description of a tool designed especially for the heavier class of milling in machine, engine, and railroad shops. 1700 w. Ir Age—May 30, 1907. No. 84666.

Molding.

The Universal System of Machine Molding. E. Ronceray. Illustrates and describes the standard Universal machines and their operation, devised with a view to making pattern plates and stripping plates in the foundry, without the help of the machine shop. 2800 w. Ir Age—June 6, 1907. No. 84733.

An Interesting Foundry Problem. L. N. Perrault. The method of molding an acid egg or still is illustrated and described. 2200 w. Ir Age—June 13, 1907. No. 85002.

Ordnance.

The Coventry Ordnance Works, Limited. An illustrated description of the various establishments of this great undertaking. 3000 w. Engr, Lond—May 31, 1907. Serial. 1st part. No. 85000 A.

Planing.

A Regenerative Reverse Planing Machine. Illustrated description of a new planer designed on the principle of balancing the forces by recoil springs. 800 w. Engr, Lond—June 7, 1907. No. 85119 A.

Protecting Device.

Planer-way Protecting Device. Illustrates and describes an efficient arrangement used at the works of the Bullard Machine Tool Co., Bridgeport, Conn., for preventing core sand, chips, etc., from getting in the ways. 500 w. Am Mach—Vol. 30, No. 26. No. 85298.

Riddle.

A Loose Ring Riddle. E. H. Mumford. Illustrates and describes the Mumford loose ring power driven foundry riddle, giving results of working tests. 800 w. Ir Age—June 13, 1907. No. 85003.

Riveting.

How to Heat and Drive Steel Rivets. James Crombie. 1st prize paper. Explains in detail the essentials of good work. 2500 w. Boiler Maker—June, 1907. No. 85006.

How to Heat and Drive Steel Rivets. J. T. Goodwin. 2nd prize paper. Considers driving rivets on a "Bull" machine, pneumatic riveting, hand or snap riveting, etc. 1500 w. Boiler Maker—June, 1907. No. 85008.

Shop Equipment.

Equipment of a Concrete Machine Shop. L. A. Alford. Illustrates and describes the general equipment of the buildings devoted to manufacturing in the plant of the United Shoe Machinery Co., at Beverly, Mass. 3800 w. Am Mach—Vol. 30, No. 24. No. 85009.

Shop Extension.

Arrangement of a Pattern Shop in a Confined Space. Oscar E. Perrigo. States the requirements and shows how a very convenient small pattern shop was obtained. Ills. 1400 w. Ir Tra Rev—June 20, 1907. No. 85147.

The Russel Wheel & Foundry Co., Detroit. Illustrates and describes improvements including the rearrangement of old buildings and the building of a new foundry and structural steel shop. 1300 w. Ir Trd Rev—June 20, 1907. No. 85146.

Sizing.

Sizing Holes without Reamers. Frank E. Shailor. Explains how it is done. Ills. 500 w. Am Mach—Vol. 30, No. 22. No. 84681.

Spring Control.

Instrument Control Springs. Charles C. Garrard. Discusses the design of such springs, the theory of flat spiral springs being considered in the present article. 1600 w. Elec Engr, Lond—May 31, 1907. Serial. 1st part. No. 84879 A.

Spur Wheels.

Spur Wheels with Circular Teeth. A discussion of the approximation of the cycloidal and involute forms, with the minimum of reference to the primary form. 2500 w. Engr, Lond—May 31, 1907. No. 84898 A.

Taps.

Remarks on the Making of Hand Taps. Erik Oberg. Information and data intended to supplement a number of previous articles. 1700 w. Mach, N Y—June, 1907. Serial. 1st part. No. 84692 C.

Tempering.

Tempering Ovens (Ueber Härteöfen). Otto Goldschmidt. Illustrated description of various types, heated by coal, coke, gas, or electricity. 2500 w. Stahl u Eisen—May 29, 1907. No. 84941 D.

Toggle-Joints.

The Ratio of Effective Pressure with Toggle-Joints. W. H. Butz. Deals with maximum results obtained with machines embodying the toggle-joint when the joint is straightened out. 900 w. Mach, N Y—June, 1907. No. 84688 C.

Tools.

Tool Room Care and Economy. F. G. De Saussure. An explanation of a system, illustrating its application. Ills. 2000 w. Eng & Min Jour—June 15, 1907. No. 85049.

Standardization of Special Tools. M. E. Ellis. Illustrates and describes a few standard types of drilling jigs and standard small parts for jigs and fixtures, as screws, bushings, and straps. 1500 w. Am Mach—Vol. 30, No. 23. No. 84794.

Triangulation.

Triangulation. Explains the layout of a "Y" connection. 800 w. Boiler Maker—June, 1907. No. 85007.

Tubes.

Inshaw's System of Manufacture of Solid Wrought-iron Tubing. W. H. Booth. Explains the process, and gives reasons why wrought iron is better than steel. 1200 w. Am Mach—Vol. 30, No. 22. No. 84682.

Welding.

"Autogenous" Welding with the Oxygen-Acetylene Blowpipe. Outlines some of the interesting features of a plant in Worcester, Mass., where this process has been installed. Ills. 1500 w. Eng News—June 27, 1907. No. 85300.

Works.

A Large Engineering Works in Holland. J. B. Van Brussell. Illustrations and details of the new plant of the A. F. Smulders Shipbuilding and Engineering Works at Schiedam. 800 w. Am Mach—Vol. 30, No. 25. No. 85149.

The Wheeling Mold and Foundry Co. An illustrated description of a well-equipped plant for the manufacture of heavy machinery. 2500 w. Ir Trd Rev—May 30, 1907. No. 84675.

MATERIALS OF CONSTRUCTION.

Abrasives.

Modern Abrasive Materials and Their Use in Shop Practice. J. Royden Peirce. Discusses kinds of abrasives, and their behavior, the principles of abrasive wheels, their form, use, etc. 3300 w. Eng News—June 6, 1907. No. 84819.

Aluminium.

Progress in the Use of Aluminium in 1906. Joseph W. Richards. Shows how improved methods of working this metal have extended its use as a light durable material and as a dioxidizing agent. 3000 w. Eng & Min Jour—June 15, 1907. No. 85053.

Cast Iron.

Manganese in Cast Iron. Herbert E. Field. Read before the Am. Found. Assn. An explanation of the effects of manganese on cast iron, aiming to reconcile conflicting statements. 2000 w. Ir Trd Rev—June 6, 1907. No. 84735.

Earthenware.

Making Vitreous Sanitary Ware. Illustrates and describes the equipment and processes of the potter. 2500 w. Met Work—June 8, 1907. No. 84767.

Fire Brick.

The Use and Abuse of Fire Brick for Locomotive Fire-boxes. J. E. Bond. Considers general details applying to the manufacture of all fire brick, the care needed, abuse, etc. 1800 w. R R Gaz—June 7, 1907. No. 84812.

Fireproof Material.

Artificial Fireproof Stones. Information in regard to fireproof materials for electric furnaces, smelting furnaces, artificial dinas material, fireproof crucibles, etc. 3800 w. Sci Am Sup—June 8, 1907. No. 84824.

Malleable Iron.

Etching Malleable Iron for the Visual Investigation of Structure. Prof. E. Heyn. Abstract of a report presented to the International Assn. for Test. Mat., Brussels Congress. Describes some things that may be learned as to the structure of iron and steel by inspecting etched surfaces, especially with the unaided eye. Ill. 1500 w. Am Mach—Vol. 30, No. 23. No. 84797.

Pipe.

A New Lock-Bar Steel Pipe. Max Kronauer. States the objections to riveted pipe, and illustrates and describes a pipe in which the adjoining edges are inserted into grooves and clamped by compression. 1200 w. Eng News—June 13, 1907. No. 85027.

Steel.

Behavior of Carbon and Phosphorus in Steel. Henry M. Howe. A discussion of J. E. Stead's explanation of the banding of carbon and phosphorus and the theory of incompatibility. 3000 w. Eng & Min Jour—June 8, 1907. No. 84837.

Tube Sheets.

Tests of Very Mild Steel Tube Sheets. A report of tests recently made at the repair shops of the Prussian railroads, describing a new sheet the construction of which meets the requirements of the heaviest service. Ills. 1000 w. R R Gaz—June 7, 1907. No. 84810.

MEASUREMENT.

Composimeter.

The Uehling Gas Composimeter. Illustrated description of an instrument which shows the quality of the flue gas, which is an index of the completeness of combustion. 2000 w. Power—June, 1907. No. 84656 C.

Computer.

A Time and Cost Computer for the Boring Mill. William Cox. Describes a circular slide rule in which the various scales have been given special values corresponding to the elements in the required calculation. 500 w. Am Mach—Vol. 30, No. 24. No. 85012.

Frames.

Punching- and Shearing-Machine Frame Calculations. Gives a method for calculating the stresses in such a frame. 900 w. Am Mach—Vol. 30, No. 23. No. 84705.

Gaging.

Gaging Systems and Gages. Joseph V. Woodworth. Calls attention to the design, construction, use, and application of measuring and testing instruments. 2000 w. Ir Trd Rev—June 13, 1907. No. 85032.

Gears.

Diagram for Finding the Strength of Bevel Gears. H. T. Millar. Gives diagram, illustrating its use by examples. 600 w. Am Mach—Vol. 30, No. 24. No. 85011.

Punching Machine.

Design of a Punching and Shearing Machine. Gives the main calculations that are necessary to get out a design. 1500 w. Prac Engr—May 24, 1907. Serial. 1st part. No. 84744 A.

Pyrometry.

Pyrometry in Modern Workshop Practice. Charles R. Darling. Discusses various types of industrial pyrometers, showing that no single pyrometer is suited to every operation, and that the instruments should be fitted for the purpose intended. Ills. 5000 w. Engr, Lond—June 14, 1907. No. 85246 A.

Sentinel Pyrometers. Discusses their application to the annealing, hardening and general treatment of tool steel. 2000 w. Ir Age—June 13, 1907. No. 85004.

Principle and Operation of the Féry Radiation Pyrometer. C. H. Wilson and Frederick Maeulen. Illustrates and describes this instrument for measuring all temperatures over 500° C. (932° F.) by merely sighting a telescope at the hot body and reading the results direct from a needle over a graduated scale of a millivoltmeter. 2000 w. Sch of Mines Qr—April, 1907. No. 85019 D.

Steam Flow.

Formulas for the Flow of Steam in Pipes. Prof. G. F. Gebhardt. A comparison of accepted formulas, with curves showing the drop in pressure for different pipe sizes and velocities. 2500 w. Power—June, 1907. No. 84655 C.

Torsion.

A New Torsion-Meter. B. Hopkinson and L. G. P. Thring. Describes an apparatus designed by the authors, reporting tests. Ills. 2700 w. Engng—June 14, 1907. No. 85242 A.

POWER AND TRANSMISSION.

Blast Furnace Gases.

The Utilization of Blast Furnace Gases for Power Production. Albert L. O. Genter. Shows how the problems of eliminating flue dust from blast furnace gases, and the construction of gas engines large enough to meet the demands of power for a steel plant, were solved. 2500 w. Min Rept—June 13, 1907. Serial. 1st part. No. 85082.

Compressed Air.

Standards of Efficiency in Compressed Air Practice—The Air Compressor as an Air Meter. Frank Richards. Considers the indicator card as a basis for computing efficiency, the influence of temperature, and the effect of air valves. 1800 w. Mach, N Y—June, 1907. No 84693 C.

The Proper Installation and Use of Compressed Air in Railway Shops and Manufacturing Establishments. W. P. Pressinger. Deals with pneumatic tools, their applications and related subjects. Discussion. 7500 w. Pro Cent Ry Club—May 10, 1907. No. 85043 C.

The Use of Coolers in Air Compression. Frank Richards. Points out the advantages, and discusses cost, the two-stage system, and other matters. 1200 w. Eng & Min Jour—June 1, 1907. No. 84707.

Cost.

Steam Power vs. Gas Power. D. L. Fagnan. Information relating to comparisons between costs of power from gas engines, and steam or electricity. 1000 w. Engr, U S A—June 1, 1907. No. 84781 C.

Use of Exhaust Heat and Comparative Cost of Installation. L. G. Findlay. An investigation of the cost of steam and gas plants, and matters related. 1500 w. Engr, U S A—June 1, 1907. No. 84782 C.

Cranes.

150-Ton Hammer Derricking-Crane. Illustrates and describes a crane erected at Birkenhead, which is a modification of the hammer-head type. Electricity is used as the motive power. Plate. 2000 w. Engng—June 7, 1907. No. 85113 A.

A Novel Lumbering Crane. Henry Hale. Illustrated description of the McGiffert loader, which can be utilized as a locomotive or stationary engine, for skidding logs and piling them for transportation. 1100 w. Sci Am Sup—June 15, 1907. No. 85017.

Electric Driving.

The Driving of Wood-Working Machines by Electricity. Presents the advantages of electric driving and gives information in regard to its application. Ills. 4000 w. Engr, Lond—June 7, 1907. No. 85118 A.

Gas Power.

The Gas-power Situation in America. F. E. Junge. Gives a short résumé of the growth and extent of power application in the United States, and a discussion of the gas-power situation from the viewpoint of a foreign observer ot American industrial conditions. 2200 w. Power—June, 1907. No. 84654 C.

Grab Buckets.

Recent Types of Grab Buckets for the Handling of Heavy Material (Types Récents de Bennes-Griffes pour la Manutention des Matières Pondéreuses). Illustrated description of several types especially adapted for loading and discharging ships. 2000 w. Génie Civil—May 25, 1907. No. 84911 D.

Power Plants.

Hydro-Electric Power versus Steam for Industrial Plants. H. von Schon. The fourth and last article of a series. Outlines the professional equipment needed by an engineer expected to report on a hydro-electric project, and the essential features of the examination on which to base conclusions. 5000 w. Engineering Magazine—July, 1907. No. 85311 B.

Power Plant Equipment of the Boston Store. Illustrates and describes the machinery for furnishing light, heat and power in the Charles Netcher building in Chicago, Ill. 2000 w. Engr, U S A—June 15, 1907. No. 85088 C.

The Power Plant of the Cleveland, O., Arcade. H. W. Woodward. Illustrates and describes modern ways of getting best efficiency in a plant where compactness was imposed by severe conditions. 3300 w. Engr, U S A—June 1, 1907. No. 84780 C.

STEAM ENGINEERING.

Boiler Explosions.

Boiler Explosions. Editorial discussion of causes. Maltreatment and ignorance, bad design, neglect, overheating, deterioration, etc., are considered. 4500 w. R R Gaz—June 7, 1907. No. 84800.

Boiler Waters.

How to Judge Boiler Waters from Analyses. John G. A. Rhodin. Outlines how to draw conclusions from simple water analysis, illustrating by actual examples. 3000 w. Engr, Lond—May 31, 1907. No. 84895 A.

Combustion.

Efficiency in the Burning of Fuel Under the Steam Boiler. William D. Ennis. This second article of a series discusses the regulation and control of furnace draft. Ills. 2000 w. Engineering Magazine—July, 1907. No. 85309 B.

Condensation.

Latest Development in Condensing Plants. S. Zylberlast. Reviews the development of condensing plants from the time of their first appearance in the year 1695 up to the present day. Ills. 4000 w. Prac Engr—June 14, 1907. Serial. 1st part. No. 85235 A.

Exhaust Steam.

Back Pressure in Exhaust Steam Heating. Charles L. Hubbard. Shows graphically the important features connected with the raising of the initial or boiler pressure, or increasing the cut-off of the engine to offset this loss. 700 w. Heat & Vent Mag—June, 1907. No. 85265.

Steam Power vs. Gas Power. F. W. Ballard. A comparison showing the advantages to the steam engine from using exhaust steam heating. 2800 w. Engr, U S A—June 15, 1907. No. 85092 C.

Germany.

Recent Aims and Achievements in German Heat-Motor Construction (Neuere Ziele und Erfolge des Deutschen Wärmekraftmaschinenbaues). H. Dubbel. The first part of the serial begins a description of recent developments in steam engines and turbines. Ills. 4000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—May 18, 1907. No. 84983 D.

Governors.

Experience with a Putnam Engine. W. H. Wakeman. Gives an experience with an old-fashioned Putnam engine of value to engineers in charge of any kind of a slow-speed governor that responds slowly to changes in the load carried. Ills. 900 w. Power—June, 1907. No. 84652 C.

Governors for High-Speed Engines. A. Houlson. Describes methods of governing steam engines, and types of governors. Ills. 3500 w. Mech Engr—June 8, 1907. Serial. 1st part. No. 85096 A.

Speed Variations Due to Engine Governors (Variations Périodiques de Vitesse dues aux Régulateurs des Moteurs). P. Boucherot. Gives a mathematical discussion of the theory of governors and points out the discrepancies between their theoretical effect and the results obtained in practice. Ills. 9000 w. Revue de Mécanique—May 31, 1907. No. 84993 E + F.

Natural Draught.

Construction of Natural Draught Furnaces. Walter J. May. Discusses some of the essentials of good natural draught, and the uses to which it may be applied. 1800 w. Prac Engr—May 31, 1907. No. 84877 A.

Stokers.

Dust-Fuel Stokers and Auxiliary Plant. W. R. Harrison. Read before the Leeds Univ. Engng. Soc. Discusses the conditions for complete combustion, methods of firing dust fuel, especially with natural draught and fuel mechanically introduced independent of the air supply—the Schwartzkopff system. 3500 w. Ir & Coal Trds Rev—May 24, 1907. No. 84764 A.

Superheating.

Superheated Steam for Steam Turbines. J. A. Moyer. Discusses some of the important properties of superheated steam, giving results derived from experience. 2500 w. Harvard Engng Jour—June, 1907. No. 85192 D.

Thermal Currents.

The Interchange of Heat in Steam-Engine Cylinders. W. F. Cleveland. A study of the flow of thermal currents and of the theory of the interchange of heat between the working steam and the internal surfaces of the cylinder walls and pistons. 2500 w. Engineering Magazine—July, 1907. No. 85310 B.

Turbine Plant.

Steam Turbine Plant in the Black Hills. H. Boyd Brydon. Illustrated description of the Pluma Station of the Consolidated Power & Light Co. of South Dakota and its cooling spray system for condensing water. 2000 w. Engr, U S A—June 1, 1907. No. 84779 C.

Turbines.

Recent Steam Turbine Developments. W. L. R. Emmet. Abridgement of a paper presented to the Nat. Elec. Lgt. Assn. Considers the aims of recent designs of Curtis turbines, showing the progress that has been made. 2500 w. Eng Rec—June 22, 1907. No. 85199.

First Rateau Regenerator Installed in America. F. G. Gasche. Description and test of the Rateau low-pressure turbine system at the works of the International Harvester Co., Chicago, Ill. 4000 w. Power—June, 1907. No. 84653 C.

The Steam Turbine. Leo A. Phillips. Considers particularly the Westinghouse-Parsons type of turbine, illustrating and describing its construction, its performance and commercial features. General discussion. 10500 w. Pro Ry Club of Pittsburgh—Feb. 22, 1907. No. 84662 C.

Turbines. A brief account of the necessary care to be exercised in the operation of turbines for driving generators, the two most important points being efficient lubrication and good steam. 1200 w. Elec Rev, Lond—May 25, 1907. No. 84750 A.

Is a 200 Horse Power Steam Turbine Plant Economical? (Ist eine 200 Pferdige Dampfturbinenanlage Wirtschaftlich?) W. A. Müller. Compares the small steam turbine with the piston engine of the same power as regards both first cost and operating expenses. Tables. 1500 w. Zeitschr f d Gesamte Turbinenwesen—May 20, 1907. No. 84953 D.

Valve Setting.

How to Set a Riding Cut-off Valve. Hubert E. Collins. An illustrated article giving the principal points which engineers ought to know about the action of the well-known Meyer valve. 4000 w. Power—June, 1907. No. 84651 C.

Water-Softening.

A Commonplace View of Water-Softening. E. J. Deason. Discusses water and its impurities in connection with steam engineering, and plants and processes for their removal. 3000 w. Ir & Coal Trds Rev—May 24, 1907. No. 84763 A.

Commercial Water Softening and Purification. Charles M. Hampson. From Pro. Colo. Sci. Soc. Reviews briefly successful processes for purifying and softening water and shows the saving made by purifying feed water before it enters the boilers. 2000 w. Min Rept—June 6, 1907. No. 84860.

MISCELLANY.

Aeronautics.

The Wellman Polar Airship Expedition. Illustrates and describes the arrangements made for the expedition. 2500 w. Sci Am—June 22, 1907. No. 85161.

Aeronautics in Foreign Countries (L'Aéronautique à l'Etranger). G. Espitallier. Describes the section devoted to aeronautics at the Milan Exposition in 1906 and discusses the experiments being carried on in the Italian Army. Ils. 2800 w. Génie Civil—May 4, 1907. No. 84907 D.

Air Bar.

The Compressed Air Bar. A. C. Musehold. Explains the uses of this invention for storing compressed air, with illustrated description. 1000 w. Compressed Air—June, 1907. No. 85260.

Bottle-Making.

The Leistner Bottle-Making Machine. A machine for the manufacture of glass bottles is illustrated and described, and also its operation. 3500 w. Engng—June 7, 1907. No. 85115 A.

Eighteenth Century.

Mechanical Masterpieces of the Eighteenth Century. Dr. Alfred Gradenwitz. An account of the work of Pierre Jaquet-Droz and his son, Henri Louis. Illustrates and describes three famous automatons. 1600 w. Sci Am—June 22, 1907. No. 85162.

Injuries to Vegetation.

Search for the Causes of Injury to Vegetation in an Urban Villa Near a Large Industrial Establishment. Persifor Frazer. Describes the investigation made and gives the conclusions. Also a bibliography of treatises on injuries to vegetation by furnace gases. 28000 w. Bul Am Inst of Min Engrs—May, 1907. No. 85270 D.

MINING AND METALLURGY

COAL AND COKE.

Canada.

Notes on the Mineral Fuel Supply of Canada. R. W. Ells. Discusses mineral fuels which include other substances than coal, the location of deposits, etc. 1200 w. Can Min Jour—June 15, 1907. Serial. 1st part. No. 85217.

Charcoal Burning.

Composition of Gas Given Off in Charcoal Burning (Gasverhältnisse bei der Holzverkohlung). Eduard Juon. Gives the results of elaborate experiments carried out in Russia. Tables. Serial. 2 parts. 6300 w. Stahl u Eisen—May 22 and 29, 1907. No. 84940 each D.

Coke.

Judging Coke from Its Appearance. A Thau. Trans. from *Glückauf*. Illustrates and explains the exterior characteristics of coke, from which the percentage of ash, volatile matters and water may be approximately ascertained, and other information of value. 3000 w. Ir & Coal Trds Rev—May 24, 1907. No. 84765 A.

Peat Coke. Max Toltz. Information concerning the deposits of peat, the making of peat coke, the by-products and their use. 3500 w. Jour Assn of Engng Socs—May, 1907. No. 85142 C.

Why Is It That Some Coals Coke and Others Do Not? Fred C. Keighley. Read before the Coal Min. Inst. of America. A discussion of the coking properties of coals. 6500 w. Ind Wld—June 22, 1907. No. 85212.

Coke Ovens.

Notes on By-Product Coke Ovens with Special Reference to the Koppers Oven. A. Victor Kochs. Read before the Inst. of Min. Engrs. Explains the design and construction of the coke-oven invented by Heinrich Koppers, of Essen, Germany. Ills. 5500 w. Ir & Coal Trds Rev—June 14, 1907. No. 85253 A.

A By-Product Coking Plant at Clay Cross. W. B. M. Jackson. Read before the Inst. of Min. Engrs. Illustrated description of a Simplex By-product Coke oven plant, using a compressor. 3000 w. Ir & Coal Trds Rev—June 14, 1907. No. 85250 A.

Colliery Equipment.

Operation and Equipment of the St. Clair Colliery. Floyd W. Parsons. Outside machine is driven by steam, while underground equipment is electrically driven. Ills. 1500 w. Eng & Min Jour—June 15, 1907. No. 85054.

Colorado.

The Coals of Routt County, Colorado. Arthur Lakes. Information in regard to this district, the character of the coals, especially considering the Yampa field. Map. 3000 w. Min Wld—June 15, 1907. No. 85084.

Composition.

The Composition of Coals. Frank F. Grout. Presents a graphical comparison of the chemical analyses of coals, giving classification and application to coals of United States. 4500 w. Ec Geol—April, 1907. No. 85185 D.

Electric Power.

An Alternating-Current Coal-Mining Installation. T. W. Sprague and C. K. Stearns. Illustrated description of a central power station in West Virginia, with high potential transmission and transformers where required. 2500 w. Eng & Min Jour—June 8, 1907. No. 84841.

Explosions.

Colliery Explosions and Their Causes. James T. Beard. Considers some of the many causes, believing seismic forces to be more important than barometric changes. Ills. 4000 w. Eng & Min Jour—June 1, 1907. No. 84710.

Barometric Pressure and Simultaneous Explosions of Gas in European Collieries. M. Mascart. Trans. from *Echo de Mines*. Gives information in regard to the barometric pressure at the time of the explosions at Reden, Germany, and Liévin, France, which occurred nearly simultaneously. Seems to show that a rapid fall of the barometer has an influence. Also editorial. 1500 w. Eng & Min. Jour—June 1, 1907. No. 84711.

Outbursts of Coal and Gas in the Cockshead Seam. An account of occurrences at Hanley. Full abstract of F. E. Buckley's paper before the N. Staffordshire Inst. of Min. & Mech. Engrs. Discussion. 2700 w. Ir & Coal Trds Rev—June 7, 1907. No. 85121 A.

Colliery Experimental Work of the Geological Survey. Clarence Hall. From a paper read before the Coal Min. Inst. of America. An account of a plan for experimental investigations of explosives, safety lamps, rescue apparatus, and other matters relating to safety in mine working. 1200 w. Eng & Min Jour—June 22, 1907. No. 85224.

Urpeth Colliery Explosion. A review of Mr. J. B. Atkinson's report on an explosion of firedamp and coal dust, which occurred Dec. 17, 1906. Ills. 5000 w. Col Guard—June 7, 1907. No. 85110 A.

Machine Mining.

Economies of Coal Mining by Machine. George Farmer. A summary of the economies claimed to be effected by machine mining. 700 w. Min Rept—June 13, 1907. No. 85081.

Montana.

Montana Coal Mines. J. P. Rowe. Deals with the principal producing mines, extent of development, methods of mining and handling coal, and the machinery used. 4500 w. Mines & Min—June, 1907. No. 84737 C.

Safety Devices.

Government Tests of Safety Devices for Mines. A report of tests to be made by the United States government of the various dynamites and powders, and experiments in rescue work. 1800 w. Sci Am—June 8, 1907. No. 84821.

Surveys.

Methods Used in Surveys of Coal Mines. L. D. Tracy. Deals particularly with methods used in the bituminous mines in and near Pittsburg. Map. 3800 w. Eng News—May 30, 1907. No. 84694.

Utilization.

Recent Improvements in the Utilization of Coal. Marius R. Campbell. Discusses recent improvements, especially the utilization of soft coal, lignite and peat in the manufacture of producer gas for power purposes, giving the results of fuel-tests made at St. Louis. 1700 w. Ec Geol—June, 1907. No. 85189 D.

Warwickshire.

The Thick Coal of Warwickshire. J. T. Browne. Read before the Inst. of Min. Engrs. Deals particularly with the methods of working these coal seams. 1200 w. Ir & Coal Trds Rev—June 14, 1907. No. 85255 A.

Waste.

Investigations of the Waste in Mining and Preparation of Coal. Edward W. Parker. Presented before the Coal Min. Inst. of America. Explains the character of investigations to be made by the Geological Survey, of losses through wasteful methods of operation, the causes, etc. 2000 w. Eng & Min Jour—June 22, 1907. No. 85222.

COPPER.

Africa.

The Otavi Copper and Lead Mines. J. Hartley Knight. Map with description of the nature of the deposits, and the methods of mining and smelting. 1000 w. Eng & Min Jour—June 15, 1907. No. 85050.

Assaying.

The Use of Zinc in Assaying Copper Matte, etc. Donald M. Levy. Gives experiments showing that zinc effects a more complete separation than does aluminum in assaying materials containing copper and iron. 1000 w. Inst of Min & Met, Bul. 32—May 16, 1907. No. 85042 N.

Electro-Determination of Copper and Its Separation from Mercury and Silver. H. J. S. Sand. Describes methods used and experiments carried out. 900 w. Min Rept—June 13, 1907. No. 85080.

British Columbia.

The Dominion Copper Company, Limited. An interesting account of one of the Boundary District's most important copper producers, which is increasing its output. 3000 w. Min Jour—June 1, 1907. No. 84888 A.

Lake Superior.

Practice at the Osceola Mill, Lake Superior. Lee Fraser. An illustrated account of improved methods of handling pulp and the use of the Nordberg steeple-compound stamp, which have reduced costs at this copper mine to 16 cents per ton. 1600 w. Eng & Min Jour—June 22, 1907. No. 85218.

Mine Equipment.

Novel Equipment of Tywarnhaile Copper Mine. Edward Walker. Illustrates and describes the application of the Elmore vacuum process for concentrating tion works. Ills. 3000 w. Mines & Min Jour—June 1, 1907. No. 84706.

Nevada.

Copper Deposits at Ely, Nevada. William Starr Bullock. Information in regard to the rapid development of the mines and the construction of the reduction works. Ills. 3000 w. Mines & Min—June, 1907. No. 84741 C.

A Visit to Ely, Nevada. James W. Abbott. Illustrated description of the development of this copper district, once mined for gold. 2500 w. Min & Sci Pr—June 15, 1907. No. 85166.

Newfoundland.

Mining in Newfoundland. Day Allen Willey. Information concerning the extensive deposits of copper and iron ore and their development. Ills. 1000 w. Sci Am—June 8, 1907. No. 84822.

New Jersey.

Copper Deposits of the New Jersey Triassic. J. Volney Lewis. Briefly reviews the history of copper mining in New Jersey, describing the geology of the State, and studying the origin of the ores. 5000 w. Ec Geol—April, 1907. No. 85186 D.

Production.

Copper Production in 1906 and the Present Outlook. John B. C. Kershaw. An examination of the production figures for the past seven years with a view to discovering whether the mines now worked show any great power of increasing their output. 1700 w. Elec Rev, N Y —June 1, 1907. No. 84715.

Spain.

The San Vicinte Mine, Spain. Edward Walker. An account of a new copper mine, with map and plan. 800 w. Eng & Min Jour—June 22, 1907. No. 85220.

Texada Island.

The Marble Bay Copper Deposit. O. E. Leroy. Describes these deposits on Texada Island, B. C., their geology, origin, values, etc. 2800 w. Can Min Jour—June 15, 1907. No. 85215.

Uses.

Notes on Copper. Prof. A. Humboldt Sexton. The present article deals with the physical and chemical properties, commercial copper and its varieties, impurities, burnt copper, and the uses and value. Ills. 3000 w. Mech Engr—June 8, 1907. Serial. 1st part. No. 85097 A.

GOLD AND SILVER.

Assaying.

Method for Analysis of Gold-Silver Bullion. J. E. Clennell. Describes a rapid method for the approximate analysis of bullion. The elements to be determined are gold, silver, selenium, lead, copper, iron, and zinc. 2500 w. Eng & Min Jour—June 8, 1907. No. 84840.

Black Sands.

The Auriferous Black Sands of California. J. A. Edman. A brief statement of their origin, distribution and probable value. 2000 w. Eng & Min Jour—June 1, 1907. No. 84709.

Dredging.

Gold Dredging in Tierra del Fuego. Juan D. Roberts. An illustrated account of modern methods being introduced in this placer mining region. 800 w. Min Jour—June 1, 1907. No. 84889 A.

Flotation Process.

Acid Flotation Processes at Broken Hill. F. H. Jackson. Describes the practice in the Block 14 Mill, at Broken Hill, using the Potter process. 2000 w. Min & Sci Pr—June 8, 1907. No. 84866.

Malay States.

Gold and Tin Mines of the Federated Malay States, with Especial Reference to Pahang. J. B. Scrivenor. Information concerning the deposits, workings, methods, etc. Map. 5000 w. Min Jour—June 8, 1907. Serial. 1st part. No. 85108 A.

Mexico.

The Lluvia de Oro District, Mexico. R. H. Burrows. An illustrated account of this district and the discovery of the Lluvia de Oro gold mine, describing the topography, ore bodies, geological formation, etc. 2800 w. Min & Sci Pr—May 25, 1907. No. 84678.

The Mining District of Asientos, Mexico. Bruno Newman. Illustrated description of a district situated near two smelting plants which includes promising copper, lead, and silver deposits in rhyolite and limestone. 1500 w. Eng & Min Jour —June 1, 1907. No. 84708.

Milling.

Milling at Gladstone, Colo. George P. Scholl. Describes tube milling at the Gold King mill, and successful concentration of low-grade complex ore at the Mogul mill. Ills. 1800 w. Mines & Min—June, 1907. No. 84740 C.

Montana.

Early Mining History of Montana. K. T. Harmond-Fogarty. A review of the early history of mining and of the difficulties in developing the gold and silver mines. 3500 w. Min Wld—June 8, 1907. No. 84832.

Nevada.

Goldfield, Nevada. An illustrated review of this field and its development, reporting the extreme richness of the deposits. 1500 w. Min & Sci Pr—June 8, 1907. No. 84863.

Gold Tellurides. W. J. Sharwood. Gives drawings of thin sections showing two modes of occurrence of these ores at Goldfield, Nevada. 500 w. Min & Sci Pr—June 8, 1907. No. 84867.

Water Resources of Nevada. Henry Thurtell. An account showing the available supply of water, which is so much needed for the working of gold and silver mines and for domestic purposes. Ills. 3000 w. Min & Sci Pr—May 25, 1907. No. 84677.

New Zealand.

The Undeveloped Gold-Deposits of New Zealand. W. Green. Suggestions for future development, giving results of investigations and study of the geology of the gold-deposits of the colony. 8500 w. N Z Mines Rec—April 16, 1907. No. 84890 B.

Nova Scotia.

The Richardson Mine. Percy Brown. History and illustrated description of this gold mine in Nova Scotia. 1700 w. Can Min Jour—June 15, 1907. No. 85216.

Ontario.

New Silver District in the Temagami Reserve. L. H. Mattair. Brief account, with map showing location of what promises to be a rich district. 600 w. Eng & Min Jour—June 15, 1907. No. 85251.

Queensland.

Some Croydon Gold Mines. B. Dunstan. Information concerning recent investigations made of these mines, especially with reference to Bennion's reef and the Highland Mary reef. Ills. 5500 w. Queens Gov Min Jour—May 15, 1907 No. 84871 B.

Stamp Mill.

Notes on a Modern Stamp Mill. Gilmour E. Brown. Describes two stamp mills and their work, the ore, the treatment, and gives general information. Ills. 4500 w. Inst of Min & Met, Bul. No. 32—May 16, 1907. No. 85041 N.

Tube Mills.

Notes on Some Recent Improvements in Tube Mill Practice. Kenneth L. Graham. Suggests some improvements recently occurring to the author which affect the economics of tube milling. 3500 w. Jour Chem, Met, & Min Soc of S Africa—April, 1907. No. 85093 E.

IRON AND STEEL.

Analysis.

Report of Committee on Standard Methods for the Analysis of Iron. Presented to the Am. Found. Assn. Gives methods for determining graphitic carbon, manganese, and phophorus. 1800 w. Ir Trd Rev—June 6, 1907. No. 84736.

Blast Furnaces.

Blast Furnace Practice. T. F. Witherbee. Discusses the papers of F. L. Grammer, and of J. E. Johnson, Jr. 5000 w. Bul Am Inst of Min Engrs—May, 1907. No. 85274.

The Gas-Producer as an Auxiliary in Iron Blast-Furnace Practice. R. H. Lee's paper is discussed. Ills. 1200 w. Bul Am Inst of Min Engrs—May, 1907. No. 85275.

Electric Furnace.

See Electrical Engineering, Electro-Chemistry.

Flue Dust.

The Settling and Collection of Dust in Flues. L. S. Austin. Considers the principles applicable to the settling of dust accompanying the gases from furnaces, and their analogy to the settling of sand and slime in settling tanks. 800 w. Min & Sci Pr—May 5, 1907. No. 84679.

Gas Meters.

The Measurement of Large Quantities of Gas by the Manometer (Messung Groszer Gasmengen mittels Differenzdruckes). E. Stach. Illustrates and describes a method of measuring the gas delivered from blast furnaces and coke ovens by recording manometers. Diagrams. 2000 w. Stahl u Eisen—May 1, 1907. No. 84936 D.

Minnesota.

Developments in the Colerine District. An illustrated account of the character and size of the ore deposits in these iron mines, the new development, etc. The Gilbert mine is described. 2000 w. Ir Trd Rev—June 20, 1907. No. 85148.

Nomenclature.

Uniform Nomenclature for Iron and Steel (Einheitliche Benennung von Eisen und Stahl). Dr. H. Wedding. Discusses the work of the International Congress for the Testing of Engineering Materials at Brussels in 1906, with table showing where a uniform nomenclature should be adopted. 3000 w. Stahl u Eisen—May 29, 1907. No. 84942 D.

Ore Reserves.

Iron Ore Reserves of the United States. John Birkinbine. A comparison of American supplies with European resources. A review of the iron ore situation in the United States. 2500 w. Cassier's Mag—June, 1907. No. 85179 B.

Pyrite.

The Oxidation of Pyrite. Alexander N. Winchell. Describes an attempt to produce experimental evidence that natural circulating waters will oxidize pyrite. 1200 w. Ec Geol—April, 1907. No. 85190 D.

Rolling Mill.

A Modern Mill (Ein Modernes Platinen-Triowalzwerk). Illustrated description of a plant at Jünkerath, Germany. Plate. 1500 w. Stahl u Eisen—May 8, 1907. No. 84937 D.

Scrap.

The Growth of the Scrap Movement. B. E. V. Luty. Shows the growth of scrap consumption, the uses; describes the re-rolling operations, and other processes of interest. 3500 w. Ir Trd Rev—May 30, 1907. No. 84676.

Stassano Furnace.

The Stassano Thermo-Electric Furnace. Ernest Stassano. Illustrates and describes two furnace types, which produce malleable steel with a thermal efficiency of more than 50 per cent. 2200 w. Eng & Min Jour—June 15, 1907. No. 85048.

Steel Works.

The Blast-Furnace, Steel, and Rolling-Mill Plant of the "Società Anonima degli Alti Forni e Fonderia di Piombino" (Die Hochofen-, Stahl-, und Walzwerksanlage der "Società Anonima degli Alti Forni e Fonderia di Piombino"). Fritz Lürmann. Illustrated description. 2100 w. Stahl u Eisen—May 1, 1907. No. 84935 D.

Gas and Electric Power in Continental Iron and Steel Works. J. B. van Brussel. Reviews some of the most important economies which have been applied in Europe in the manufacture of iron and steel. Ills. 2800 w. Engineering Magazine—July, 1907. No. 85305 B.

Structure.

Change of Structure in Iron and Steel. William Campbell. Considers the changes which take place in the iron-carbon series, as disclosed by recent investigations. Ills. 4000 w. Jour Fr Inst—June, 1907. No. 85137 D.

Virginia.

The Virginia Iron Industry. John J. Porter. A discussion of the past history, present conditions, and future prospects. 5000 w. Mfrs Rec—June 27, 1907. Serial. 1st part. No. 85288.

MINING.

Boring.

The Causes of the Deflection of Deep Boreholes from the Perpendicular (Die Ursachen der Abweichung der Tiefbohrungen vom Lot). Albert Fauck. Illustrated discussion with numerous examples. 1500 w. Oest Zeitschr f Berg u Hüttenwesen—May 11, 1907. No. 84944 D.

An Underground Camera. J. T. Atwood. Illustrates and describes a camera designed for photographing the sides of bore holes. 2200 w. Wis Engr—June, 1907. No. 85129 D.

Debris Commission.

Hydraulic Mining and the Federal Government in California. William W. Harts. An illustrated account of the work of the Débris Commission on the Yuba and other rivers. 1500 w. Mines & Min—June, 1907. No. 84738 C.

Diamonds.

The Premier Diamond Mine, Transvaal, South Africa. R. A. F. Penrose, Jr. Describes the general features of the diamond deposits in South Africa, and gives illustrated description of the Premier mine. 2500 w. Ec-Geol—April, 1907. No. 85188 D.

Electricity.

Electricity in Mines (La Electricidad en las Minas). Emilio Guarini. Discusses the general consideration attending its installation and its application to lighting, communication, traction and motive power problems. 10000 w. Anal Sociedad Cien Argen—Dec., 1906. No. 84933 F.

Hoisting.

Temporary Whim for Hoisting. Guy C. Stoltz. Brief illustrated description of a whim built for temporary hoisting at Mineville, N. Y. 500 w. Eng & Min Jour—June 15, 1907. No. 85047.

Lane Mill.

Conclusive Test of Lane Mill. J. A. Stewart. Gives information acquired from a test made in the State of Washington. 1000 w. Min Rept—June 13, 1907. No. 85083.

Mine Locomotives.

Tests with Various Types of Mine Locomotives (Versuche mit Grubenlokomotiven Verschiedener Systeme). Herr Wex. Gives results of elaborate tests, under service conditions, of benzol, benzine and electric locomotives, the latter including both accumulator and trolley types. Ills. Serial. 2 parts. 11000 w. Glückauf—May 4 and 11, 1907. No. 84959 each D.

Mineral Wax.

The Ozokerite (Mineral Wax) Mine of the Galizische Kreditbank, at Boryslaw, Galicia, Austria. D. M. Chambers. Read before the Inst. of Min. Engrs. Describes wax-mining and treatment. 900 w. Ir & Coal Trds Rev—June 14, 1907. No. 85252 A.

Organization.

Suggestions for Mine Staff Organization. J. Boyd Aarons. Gives a plan for apportioning duties and responsibilities of members of the operating force and conducting the work of the departments of a mine staff, particularly a gold mine. 2500 w. Eng & Min Jour—June 22, 1907. No. 85221.

Phosphate.

The Mining of Phosphate in Northern France (Der Abbau der Phosphate in Nordfrankreich). O. Tietze. Illustrated description of the deposits and mining methods. 2000 w. Glückauf—May 25, 1907. No. 84961 D.

Quicksilver.

Native Methods of Mining and Smelting Quicksilver Ore in Kweichow, China. Henry Brelich. Notes relating to the wages, prices, exchange, coinage, laws and customs used by the natives in quicksilver mining. 4800 w. Cassier's Mag—June, 1907. No. 85181 B.

Records.

Costs, Methods, and Records. W. A. MacLeod. Considers how far such records should be carried in the case of small or medium-sized mines. 3000 w. Queens Gov Min Jour—May 15, 1907. No. 84872 B.

River Channels.

The Ancient River Channels of California. George W. Kimble. A short study of this interesting subject. 700 w. Min & Sci Pr—June 8, 1907. No. 84865.

Salt.

Salt Mining Near Fleetwood. Fred. J. Thompson. Abstract of a paper and discussion before the Manchester, Eng., Geol. & Min. Soc. A sketch of the history and geology of the rock-salt deposit at Peersall, describing the methods of shaft-sinking and mining, and the Peersall salt-mine. 3000 w. Col Guard—May 24, 1907. No. 84756 A.

Shaft Sinking.

The Freezing Plant at the Klein-Rosseln Mine at Stieringen, Lorraine (Die Gefrierschacht-Anlage der Grube Klein-Rosseln bei Stieringen, Lothringen). Herr Jüngst. Illustrated description of methods used for sinking through quicksand, describing the freezing process, machines, etc. 1500 w. Glückauf—May 25, 1907. No. 84962 D.

Siberia.

Siberian Mines and Mining Conditions. A. L. Simon. Notes of the history, climate, traveling conditions, mining laws, the different districts; the iron mines, placer mining, copper mines, prospecting, labor conditions and related subjects. 10000 w. Inst of Min & Met, Bul. No. 32—May 16, 1907. No. 85040 N.

Sulphur.

The Wonderful Sulphur Mines of Louisiana. Illustrated description of remarkable deposits near the coast of the Gulf of Mexico, and the interesting methods adopted for the recovery. 1600 w. Sci Am—June 1, 1907. No. 84674.

Surveying.

Mine Surveying and Geodetic Instruments of Prof. O. Cséti (Markscheiderische und Geodätische Instrumente vom Prof. O. Cséti). Eduard Dolezal. Illustrates and describes new and improved instruments invented by Prof. Cséti of the Royal Hungarian College of Mines. Serial. 1st part. 3000 w. Oest Zeitschr f Berg u Hüttenwesen—May 18, 1907. No. 84945 D.

Tunnels.

The Cost of a Small Rock Tunnel. Francis L. Pruyn. Discusses items of expense which should be considered in a cost estimate for such work. 1100 w. Compressed Air—June, 1907. No. 85261.

Ventilation.

Statical Experiments in Air Measurement at the Hermine Shaft of the Kohlwald Mine (Statische Wettermessungsversuche auf Hermineschacht der Grube Kohlwald). Herr Seidl. Gives numerous tables of the results of elaborate tests on the circulation of air in mines with formulæ. Ills. 3500 w. Glückauf —May 18, 1907. No. 84960 D.

MISCELLANY.

Aluminum.

The Metallurgy of Aluminum in 1906. Joseph W. Richards. A review of the industry showing that the demand exceeds the supply, and that the output for 1907 will probably be several times as great as 1906. Ills. 2800 w. Eng & Min Jour—June 8, 1907. No. 84836.

Assay Furnaces.

A Comparison of Coal and Oil Muffle Furnaces. George J. Young. Plan and sections, with temperature curves and report of the test. 700 w. Min & Sci Pr—June 1, 1907. No. 84770.

Graphite.

Canadian Graphite. H. P. H. Brumell. An account of this industry, describing the character of the graphite, the methods of treatment, and discussing the demands, uses, etc. Ills. 6400 w. Can Min Jour—June 1, 1907. No. 84834.

Gypsum.

Gypsum in Sussex. W. J. Kemp and G. Alfred Lewis. Read before the Inst. of Min. Engrs. Describes the deposits, the plaster manufacture, and the mines. 2500 w. Ir & Coal Trds Rev—June 14, 1907. No. 85254 A.

Joplin, Mo.

Origin of Lead and Zinc Ore Bodies in Joplin, Missouri, District. Otto Ruhl. Points out the structural features that determine the method of ore deposition in this field. Maps. 3500 w. Min Rept —June 20, 1907. No. 85228.

Lime.

The Manufacture of Lime and of Carbonic Acid Gas in the Chemical Industry (La Fabrication de la Chaux et du Gaz Carbonique dans l'Industrie Chimique). E. Nihoul. The first instalment discusses several types of lime-burning furnaces, methods of firing, operation, products, etc., both theoretically and practically. Ills. Serial. 1st part. 8400 w. Bull Sci d l'Assn des Elèves—April, 1907. No. 84903 D.

Magmas.

Magmatic Emanations. Francis Church Lincoln. A statement of what is known in regard to these emanations and their bearing on ore deposits. 4000 w. Ec-Geol—April, 1907. No. 85187 D.

Mica.

Mica in Ontario. E. T. Corkill. Reviews the mica mining industry of Canada, describing the peculiarities of the deposits and the Smith mine. Ills. 1800 w. Can Min Jour—June 15, 1907. No. 85214.

Mining Law.

The Reform of the United States Mineral Land Law. R. W. Raymond. Discusses the mineral-land laws, the attempts at reform, and the remedy for present abuses. 1500 w. Eng & Min Jour—June 8, 1907. No. 84839.

Mining Sociology.

A Brief Study of Social Conditions in the Bituminous Coal Region of Pennsylvania. C. L. Fay. Read before the Coal Min. Inst. of America. Discusses briefly the classes of a mining town and their relation to each other, and the remedies for undesirable conditions. 1200 w. Eng & Min Jour—June 22, 1907. No. 85223.

Oil Fields.

Sketch of the Oil Fields of Colorado. Arthur Lakes. Reviews the oil possibilities in Colorado, giving information in regard to the productive fields, the quality of the oil, and the future outlook. 1400 w. Min Wld—June 1, 1907. No. 84720.

New Russian Oilfields: The Northern Caucasus and the Petchora Basin. Reports rich oilfields in the Kubansky Oblast. 1500 w. Min Jour—June 18, 1907. No. 85109 A.

Pipe Line.

Proposed Long Rifled Pipe Line for California Oil. Describes a new line, 256 miles long, extending from Delano to Porta Costa. Diagram. 1000 w. R R Gaz—June 7, 1907. No. 84806.

Platinum.

Platinum Supply and Demand. E. de Haupick. Information in regard to the production, prices, localities, etc. 1200 w. Min Wld—June 8, 1907. No. 84833.

Settling Velocities.

Velocity of Galena and Quartz Falling in Water. Robert H. Richards. Supplementary to former papers by the author on Close Sizing Before Jigging, and Sorting Before Sizing. 4800 w. Bul Am Inst of Min Engrs—May, 1907. No. 85271 C.

Tin.

A Tin Deposit Near Spokane. A. R. Whitman. An account of a seemingly rich deposit almost in the suburbs of this mining city. 1800 w. Min & Sci Pr—June 1, 1907. No. 84769.

Revival of the South Crofty Tin Mines, Cornwall. Edward Walker. An illustrated account of reorganization. A number of small mines will be worked by one corporation, introducing new equipment and new methods. 1000 w. Eng & Min Jour—June 8, 1907. No. 84838.

The Tasmanian Tin Industry. Ralph Stokes. An illustrated article describing the deposits, and the geological and industrial features of interest. 2200 w. Min Wld—June 8, 1907. Serial. 1st part. No. 84831.

Veins.

The Formation and Enrichment of Ore-Bearing Veins. George J. Bancroft The relationship between "porphyry" and ore is discussed and the views of the writer explained in detail. 8000 w. Bul Am Inst of Min Engrs—May, 1907. No. 85273 C.

Mutual Displacement by Intersecting Veins. Walter Harvey Weed. Illustrations showing peculiar seams which may explain faulting on a larger scale. 600 w. Eng & Min Jour—June 15, 1907. No. 85052.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Derailments.

One Cause of Derailments. W. R. M'Keen, Jr. Editorial, discussing the proper location of side bearings, together with the amount of vertical clearance between them. 1100 w. R R Gaz—June 14, 1907. No. 85072.

A Possible Cause for Wrecks. H. M. Perry. Discusses derailments due to excessive loads on side bearings. 1200 w. Ry Mas Mech—June, 1907. No. 84827.

Facilities.

Necessary Expansion of Railroad Facilities. From an address before the Chamber of Commerce at Syracuse, N. Y. Showing the rapid increase in the commerce of the nation and the need of great increase of facilities, and matters bearing upon railroad operation. 2000 w. Ry & Engng Rev—June 22, 1907. No. 85230.

Oscillations.

The Oscillations of Rolling Stock at High Speeds (Les Oscillations du Matériel dues au Matériel lui meme et les Grandes Vitesses des Chemins de Fer). Georges Marié. The first instalment deals with oscillations due to the unbalanced reciprocating parts of locomotives and to tapered tires. Mathematical discussion with practical illustrations. Ills. Serial. 1st part. 18500 w. Rev Gen des Chemins de Fer—May, 1907. No. 84902 G.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Recent Development in Air Brake Control Apparatus. F. H. Parke and S. W. Dudley. An illustrated discussion of recent rapid developments and fundamental changes in the control apparatus and the requirements to be met. 3000 w. R R Gaz—June 9, 1907. Serial. 1st part. No. 84811.

The Value of Straight Air Brakes. Describes the straight air-brake system, discussing the cost and maintenance, etc. 1400 w. Elec Ry Rev—June 15, 1907. No. 85078.

Air Brakes on the New York Central Electrical Equipment. Extracts from a paper by S. W. Dudley, read at Columbus, Ohio. Describes the brake equipment and its operation. Diagrams. 3000 w. Ry & Engng Rev—June 1, 1907. No. 84730.

The Westinghouse Improved High Speed Brake on the Santa Fe. An account of the development of the Westinghouse brake, referring to the various equipments which have been used by the Santa Fe and the dates when they were applied. 3500 w. Ry Age—May 31, 1907. No. 84729.

Car Repairs.

The Cost of Freight Car Repairs. M. K. Barnum. Gives a form, classifying the cost of repairs, aiming to keep a record that will make possible keeping down the cost which has been constantly increasing. 500 w. R R Gaz—June 14, 1907. No. 85075.

Cars.

Steel Passenger Equipment. Charles E. Barba and Marvin Singer. The first of a series of articles aiming to advance methods by which the fundamental laws and principles governing the action of the structural materials, under simple and combined stresses, may be applied to the design of steel passenger equipment so as to secure maximum strength with minimum weight. 3000 w. Am Engr & R R Jour—June, 1907. Serial. 1st part. No. 84784 C.

All Steel Passenger Service Cars. Explains the reasons for building steel cars and illustrates and describes the design adopted by the Pennsylvania Railroad. 2800 w. Am Engr & R R Jour—June, 1907. No. 84790 C.

Steel Passenger Cars on the Pennsylvania Railroad. Briefly outlines the development in passenger cars, aiming to increase strength and lessen cost of maintenance, and gives an illustrated description of types of steel cars under construction for the Pennsylvania R. R. 3700 w. Ry Age—June 7, 1907. Serial. 1st part. No. 84829.

Steel Passenger Cars for the Pennsylvania Railroad. Gives illustrated description of the general types of steel passenger equipment adopted, 200 cars having been ordered. 5000 w. R R Gaz—June 14, 1907. No. 85077.

Structural Steel in Freight Car Construction. G. A. Akerlind. Read before the Scandinavian Tech. Soc., in Chicago. Reviews the development and calls attention to strong features, discussing design. Ills. 3500 w. Ry & Engng Rev—June 15, 1907. No. 85086.

An 80-Ft. Flat Car Trussed with Steel Cables. Illustrates and describes cars built for the Belgian Lines of the Northern Railway of France for carrying long rails. States the requirements. 700 w. Eng News—June 13, 1907. No. 85026.

75-Ton Steel Flat Car. Brief illustrated description of a car for carrying heavy machinery, castings, etc., built for the Lake Shore & Michigan Southern Railway. 600 w. Am Engr & R R Jour—June, 1907. No. 84787 C.

Steel-Frame 50-Ton Gondola Cars: Wabash Railway. Plans and description of high-capacity cars for coal and freight service in which a very substantial steel underframe is used, with sides, ends and floor of timber. 1200 w. Eng News—June 13, 1907. No. 85024.

A New Clearance-Measuring Car for the Baltimore & Ohio R. R. J. H. Milburn. Briefly describes previous methods of measurement and gives illustrated description of a new car for this work. 2500 w. Eng News—June 13, 1907. No. 85023.

Compression.

Compression in Locomotive Cylinders and Means for Its Relief. H. G. Manning. Calls attention to compression in locomotive engine cylinders as demonstrated by the St. Louis tests, the means of relief and the benefits. 2500 w. R R Gaz—June 7, 1907. No. 84807.

Connectors.

Automatic Connectors for Air and Steam. Illustrated descriptions of the principal types of connectors for air and steam pipes now in use. 1700 w. Ry Mas Mech—June, 1907. No. 84828.

Dynamometers.

A New Railway Car Dynamometer. A. H. Emery, Jr. Illustrates and describes an instrument for recording the pull or push between the locomotive and train. Explains the records made, the general principles of the apparatus, etc. 3500 w. Am Mach—Vol. 30, No. 22. Serial. 1st part. No. 84680.

Some New Dynamometers (Circa Alcuni Nuovi Dinamometri). Federigo Giordano. The first instalment illustrates and describes several forms of traction dynamometer. Serial. 1st part. 5500 w. L'Industria—May 19, 1907. No. 84923 D.

A Recording Machine for Dynamometer Tests on Railway Trains. An illustrated description of the machine and the record made, while in use by the railway department of the International Correspondence Schools. 2000 w. Eng News—June 6, 1907. No. 84816.

Electrification.

The Electrification of the West Shore Railroad between Utica and Syracuse. An illustrated account of this recently completed work and of the service proposed. 3000 w. Elec Rev, N Y—June 22, 1907. No. 85211.

West Shore Electrification Between Utica and Syracuse. Explains the reasons for the methods adopted in this undertaking, and gives an illustrated detailed description of the electric system, transmission lines, etc. 5000 w. St Ry Jour—June 8, 1907. No. 84842.

Fireboxes.

Locomotive Fireboxes with Expansion Side Sheets. Describes the Langbridge firebox, with illustrations and report of their use. Also editorials. 2000 w. Eng News—June 20, 1907. No. 85159.

Locomotive Lubrication.

Recommendations as to Practice in Locomotive Lubrication. Report of committee at the convention of the Ry. Mas. Mechs.' Assn. 800 w. Eng News—June 20, 1907. No. 85157.

Locomotive Performance.

Ton-Mile-Per-Hour. G. H. Windsor. Discusses the question of fair rating of locomotive performance. Ill. 1200 w. Ry & Loc Engng—June, 1907. No. 84774 C.

Locomotives.

British Locomotives in 1906. Charles Rous-Marten. Reviews the main features of British locomotive practice and performance for the year just ended. Ills. 6300 w. Bul Int Ry Cong—May, 1907. No. 85289 E.

Some Remarkable Locomotives of 1906. J. F. Gairns. Illustrated descriptions of selected locomotives. 3000 w. Cassier's Mag—June, 1907. No. 85183 B.

Articulated Locomotives for Road Service on Great Northern Ry. Illustrated detailed description of engines for heavy service. 800 w. Ry & Engng Rev—June 8, 1907. No. 84861.

DeGlehn Compound for the Paris-Orleans Railway. Illustrated description of a type of which 20 have recently been built in America on the metric system of measurements. 2000 w. R R Gaz—June 7, 1907. No. 84802.

Four-Cylinder Compound Express Locomotive for the Danish State Railway. Illustrations and dimensions of an interesting type of engine. Plate. 200 w. Engng—June 14, 1907. No. 85243 A.

Mallet Compound Freight Locomotive. Illustrated detailed description of engines for the Great Northern Railway. 900 w. Am Engr & R R Jour—June, 1907. No. 84785 C.

Pacific Locomotive for the Atlanta & West Point. Illustrated description of 4-6-2 locomotives which are excellent examples of modern heavy passenger engines. 1200 w. R R Gaz—June 7, 1907. No. 84805.

Pacific Type Locomotive for Heavy Express Service on the Pennsylvania R R. Brief illustrated description of an engine weighing 173,550 lbs. just put in service. 400 w. Eng News—June 20, 1907. No. 85152.

Simple Ten-Wheel Locomotive. Illustrated description of locomotive equipment for the Chicago & Northwestern Railway. A simple ten-wheel locomotive with Walschaert valve gear is shown. 900 w. Am Engr & R R Jour—June, 1907. No. 84793 C.

Six-Coupled Bogie Tank Locomotive; Midland Railway. General view and sectional elevation, with description. 700 w. Engng—May 31, 1907. No. 84892 A.

New Locomotives for the Italian State Railways (Nuove Locomotive delle Ferrovie Italiane di Stato). Illustrated detailed description of new rolling stock. Serial. 1st part. 3000 w. Il Monitore Tech—May 20, 1907. No. 84925 D.

Consolidation (2-8-0) Type, Compound Locomotive,—St. Gothard Railway. Illustrated description. 700 w. Mech Engr—June 22, 1907. No. 85379 A.

The Most Powerful Express Locomotive Ever Built. Illustrates the first and latest locomotives of the Pennsylvania Railroad, describing the most powerful engine built up to this time. 1200 w. Sci Am—June 29, 1907. No. 85312.

Milan.

Railway Exhibits at the Milan Exposition, 1906 (Die Eisenbahnbetriebsmittel auf der Ausstellung in Mailand 1906). Herr Metzeltin. Illustrated detailed description of locomotives, cars, etc., exhibited. 6500 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—May 14, 1906. No. 84977 D.

Steam and Electric Railway Traction Exhibit at the International Exposition at Milan, 1906 (Ueber die Fahrbetriebsmittel für Eisenbahnen und Straszenbahnen auf der Internationalen Ausstellung in Mailand, 1906). E. A. Ziffer. Detailed description of the various types of steam and electric locomotives exhibited. 6000 w. Mitt d Ver f d Förd d Lokal u Straszenbahnwesens—April, 1907. No. 84934 D.

Oil-Burning.

A Solution of the Oil-Burning Locomotive Problem. Harrington Emerson. Considers the differences between oil and coal burning, and the modifications necessary in oil-burning locomotives, describing the improved oil-burning methods introduced on the Santa Fè System and the results. 3000 w. R R Gaz—June 7, 1907. No. 84801.

Reports.

Master Car Builders' Reports. Gives report on tests of M. C. B. couplers, and abstracts of other important reports. Ills. 13500 w. R R Gaz—June 21, 1907. No. 85173.

Simplon.

Operating Arrangements of the Simplon Railway (Die Betriebseinrichtungen der Simplonbahn). Karl Pallasmann. Describes the lighting, ventilation, etc. Ills. 3000 w. Oest Wochenschr f d Oeff Baudienst—May 25, 1907. No. 84963 D.

Speed Control.

New Apparatus for Controlling the

Speed of Trains. H. P. Maas-Geesteranus. Illustrates and describes apparatus which has been in use for some time in Holland. 1000 w. Bul Int Ry Cong—May, 1907. No. 85291 E.

Superheating.

The Baldwin Superheater. Illustrated description of a locomotive, equipped with a smokebox superheater, which is being exhibited at Jamestown Exposition. 600 w. R R Gaz—June 7, 1907. No. 84803.

Simple Locomotive Fitted With Improved Smoke Tube Superheater. Wilhelm Schmidt. Illustrates and describes a Swiss locomotive fitted with the author's latest design of superheater, showing the tendency toward a higher degree of superheat. 2000 w. Am Engr & R R Jour—June, 1907. No. 84792 C.

Train Lighting.

The Verity Dalziel System of Train Lighting. Describes a system in which the lamps are supplied at a constant voltage, the regulation being effected by electrical apparatus. Ills. 2000 w. Elect'n, Lond—May 24, 1907. No. 84754 A.

Train Stop.

Phillips Automatic Train Stop. Illustrated description of an apparatus for automatically applying the brakes on a train, which has been in service in England for two years. 1200 w. R R Gaz—May 31, 1907. No. 84668.

Valve Gears.

Results of Use of Different Valve Gears on Locomotives. From the report of committee of the Am. Ry. Master Mechs.' Assn. Discusses valve-actuating mechanism and some systems of steam distribution. 1800 w. Eng News—June 20, 1907. No. 85153.

NEW PROJECTS.

Africa.

The Railways of the Upper Congo. Demetrius C. Boulger. An illustrated account of what the Belgians have accomplished, describing two railways constructed in Central Africa. 3800 w. Engineering Magazine—July, 1907. No. 85307 B.

China.

The Great Interior Trunk Line of China. An interesting illustrated account of the construction of the road to connect Peking and Canton. The Peking-Hankow portion is in operation. 2800 w. R R Gaz—June 21, 1907. No. 85174.

Great Central.

Great Central Railway Improvements. Describes the establishing of new connections requiring the widening of a bridge and the construction of a skew span bridge over a mill siding, and other schemes. 1200 w. Engr, Lond—May 31, 1907. No. 84897 A.

Panama R. R.

The Rebuilding and Double Tracking of the Panama R. R. R. Budd. Illustrated description of the work of rebuilding and double-tracking this railroad. 2000 w. Eng News—June 13, 1907. No. 85022.

Southern Pacific.

The Proposed Klamath Falls Line of the Southern Pacific. Illustrated description of a change of route in northern California and Oregon, which will give relief from heavy grades and curvature. 8000 w. R R Gaz—June 7, 1907. No. 84808.

Tehuantepec.

The Tehuantepec National Railway. Illustrated description of this reconstructed railway in Mexico, connecting ports on the Gulf of Mexico and on the Pacific Ocean, with information relating to it. 3000 w. Eng Rec—June 22, 1907. No. 85196.

PERMANENT WAY AND BUILDINGS.

Engine House.

An English Rectangular Engine House with Radial Tracks. Illustrated description of an engine house recently built at London, England, by the Great Western Ry. which is notable for the number of locomotives accommodated and the arrangement of the stalls. 1000 w. Eng News—June 13, 1907. No. 85025.

Freight Stations.

Remarks on Freight Stations in North America (Einige Bemerkungen über die Güterbahnhöfe in Nordamerika). Herrn Blum and E. Giese. Illustrates and describes freight terminal arrangements in several of the leading cities of the United States. 6000 w. Serial. 2 parts. Zeitschr d Ver Deutscher Ing—May 11 and 25, 1907. No. 84980 each D.

Gage.

Changing the Gage on the Louisville & Nashville. Reuben Wells. Describes the changing of gage from 5 ft. to standard (4 ft. 8½ in.) which was done in 1886. Diagrams. 2800 w. R R Gaz—June 7, 1907. No. 84804.

Maintenance Plants.

The Electrical Maintenance Plants of the New York Central & Hudson River Railroad Company. Illustrated detailed description of the shop construction of an electrified steam railroad, which is to care for the rolling stock used in the New York electric zone. 3500 w. St Ry Jour—June 8, 1907. No. 84843.

Rail Corrugation.

The Corrugation of Rails. Describes investigations carried out on the North-Eastern Railway, England, with table of tests. Ills. 2500 w. Engng—June 14, 1907. No. 85241 A.

Rails.

Concerning Rail Metal. Letters and editorial discussing the cause of breakage of steel rails and the remedy. 3000 w. Elec-Chem & Met Ind—June, 1907. No. 84777 C.

Open Hearth Steel Rails. Benjamin Talbot. Read before the Am. Soc. for Test. Mat. Gives results from the continuous open hearth process. 1500 w. Ir Age—June 27, 1907. No. 85294.

Standard Specifications for Steel Rails. Recommended by the Committee of the Am. Soc. for Testing Materials. 1200 w. Eng Rec—June 29, 1907. No. 85327.

The Steel Rail Discussion, American Society for Testing Materials. 9000 w. Ry & Engng Rev—June 29, 1907. No. 85360.

Shops.

A Few Specialties of the Elkhart Shops. Illustrates and describes interesting specialties introduced into these shops of the L. S. & M. S. Ry. 1800 w. Ry Mas Mech—June, 1907. Serial. 1st part. No. 84826.

Recent Shop Construction. Illustrates and describes the Burnside shops of the Illinois Central. 1800 w. R R Gaz—June 14, 1907. No. 85076.

Machine Tool Equipment of the E. P. & S. W. Ry. El Paso, Tex., Shops. Describes the machine tool equipment and layout of these shops. 2500 w. Ry & Engng Rev—June 8, 1907. No. 84862.

Signaling.

A New Signaling Machine System for the Automatic Control of Railroad Trains. Illustrates and describes the invention of Thomas E. Raymond Phillips, recently tested in England, which repeats in the engine cab, the signal of tne semaphore, and blows the whistle, as well as gradually applying the brakes. 2000 w. Sci Am—June 15, 1907. No. 85013.

Station.

The Reconstruction of the Valenciennes Station (La Reconstruction de la Gare de Valenciennes). MM. Cossmann and E. Despono. The first number of the serial discusses the history of the Valenciennes station of the Northern Railway of France, and describes the general arrangement of the tracks, buildings and platforms of the new installation. Ills. Serial. 1st part. 3500 w. Rev Gen des Chemins de Fer—May, 1907. No. 84901 G.

Stubai.

The Stubai Valley Railway (Die Stubaitalbahn). A description of this railway in the Alps, giving plan and profile, details of construction and operation, etc. Serial. 1st part. 2500 w. Eisenbahntech Zeitschr—May 22, 1907. No. 84949 D.

Terminals.

Steam and Electric Locomotive Terminals of the New York Central at Croton and North White Plains. Illustrated detailed description of the extensive terminal facilities at these points where the change will be made from steam to electricity. 2000 w. R R Gaz—June 14, 1907. No. 85073.

Warehouses.

New Terminal Warehouses. Illustrates and describes the construction and equipment of the Illinois Central Railroad Company's building at New Orleans. 3000 w. Ins Engng—June, 1907. No. 85193 C.

Water Supply.

Water Supply of the Eastern Railway of New Mexico. William Archer. Describes the arrangement for the supply of boiler water along this line. Includes a 100,000-gallon tank, water pumped 1½ miles, distribution by water cars, treatment, etc. 3500 w. Ry Age—June 21, 1907. No. 85229.

TRAFFIC.

Car Shortage.

Address of Secretary Moseley to the M. C. B. Convention. Discusses car shortage and matters relating to it. 2500 w. R R Gaz—June 21, 1907. No. 85172.

Engine Loadings.

A Comparison of Cooper's E 50 Loading with Recent Heavy Locomotives. Gives a comparison compiled under the direction of C. F. Loweth, of the Chicago, Milwaukee & St. Paul Railway. 1000 w. Eng Rec—June 15, 1907. No. 85060.

Freight.

Science of Freight Transportation. C. L. Bardo. Discusses some of the essentials of good freight transportation. General discussion. 14000 w. Pro N Y R R Club—May 17, 1907. No. 85123.

Freight Cars.

Practical Means for Increasing the Earning Capacity of Freight Cars. J. E. Muhlfeld. Considers the classification of cars, their design, construction, repairs, inspection, loading and unloading, distribution and movement, etc., with reference to the present car shortage. Discussion. 21800 w. Pro Ry Club of Pittsburgh—March 22, 1907. No. 85122 C.

Freight Tariffs.

A Modern Tariff. Gives a recently issued tariff of the New York Central & Hudson River and West Shore railroads, covering charges for special freight train movements. An example of the complicated requirements of the present Interstate Commerce Commission rules for filing tariffs. 1500 w. R R Gaz—May 31, 1907. No. 84669.

MISCELLANY.

Accounting.

A Defective Accounting System. Editorial giving objections to the accountant's recommendations adopted by the Interstate Commerce Commission. 1800 w. R R Gaz—June 21, 1907. No. 85171.

Curvature.

Moment of Inertia and Curvature. G. R. Henderson. A study of the effect of the moment of inertia of an engine in being rotated about a vertical axis when entering a curve. Diagram. 2000 w. R R Gaz—June 7, 1907. No. 84809.

Italy.

A Glance at Railway Legislation (Uno Sguardo alla Legislazione Ferroviaria). A discussion of recent railway legislation in Italy. 5000 w. Boll Soc Ing e Arch Italiani—May 15, 1907. No. 84918 C.

The Management of the State Railway (L'Ordinamento delle Ferrovie di Stato). A synopsis of the legislation governing the organization and management of the Italian State Railway. 2200 w. Revista Gen d Ferrovie—May 12, 1907. No. 84922 C.

Organization.

Need for Getting Together on the Railroad Situation. J. W. Midgley. The first of a series of letters discussing the present railway situation and suggesting the organization of executive officers. 3300 w. Ry & Engng Rev—June 15, 1907. Serial. 1st part. No. 85087.

STREET AND ELECTRIC RAILWAYS

Boston.

Rapid Transit in Boston and Vicinity. Edward Hungerford. An account of present conditions and the plan for transit relief, extensions and improvements. Ills. 3000 w. Elec Ry Rev—June 1, 1907. No. 84727.

Brooklyn.

The Franklin Avenue Improvement on the Brighton Beach Line of the Brooklyn Rapid Transit Company. Re-alignment of an elevated section of about 1500 ft., with the erection of a new station, and remodeling of a junction station is illustrated and described. 1200 w. St Ry Jour—June 22, 1907. No. 85209.

California.

The Northern Electric Railway. An illustrated detailed description of an extensive interurban line in northern California, and of its equipment and operation. 2500 w. Elec Ry Rev—June 8, 1907. No. 84868.

Car-Meters.

Results Obtained by the Use of Car-Meters. M. Wattmann. Abbreviated translation of replies received in response to questions sent out, reporting results on the Continent. 5000 w. Elect'n, Lond—May 31, 1907. No. 84883 A.

Cars.

The New Steel Cars of the Hudson Companies. Hugh Hazelton. Illustrated detailed description of the rolling stock for lines running in tunnels under the Hudson River, and under city streets. 2200 w. St Ry Jour—June 8, 1907. No. 84844.

Car Wiring.

Car Wiring and Piping Practice of the Metropolitan West Side Elevated Railroad, Chicago. Illustrates and describes the wiring and arrangement of apparatus on fifty cars recently put in service. 1400 w. St Ry Jour—June 15, 1907. No. 85065.

Electric Traction.

The Philadelphia & Western Railroad. Illustrated detailed description of heavy electric traction for high-speed transportation. 6000 w. St Ry Jour—June 15, 1907. No. 85064.

Equipment.

The Effect of Topography, Tonnage and Time on Electric Railway Equipment. W. N. Smith. Considers these fundamental elements in their relation to the proportioning electrical equipment to the work to be done. 4500 w. Sib Jour of Engng—June, 1907. No. 85134 C.

Extension.

Ravenswood Extension of the Northwestern Elevated Railroad. Illustrated description of a new elevated structure near Chicago. 1000 w. Elec Ry Rev—June 22, 1907. No. 85225.

Feeders.

Direct-Current Feeder Calculations for Railways. Explains general principles, equally applicable to alternating-current feeders, giving formulæ. Diagrams. 2200 w. Elec Age—June, 1907. No 84771 C.

Gyroscope.

The Theory of the Gyroscope. An explanation of the theory, referring to its application to the Brennan mono-rail car. 1200 w. Engng—June 7, 1907. No. 85116 A.

Italy.

The Valle Brembana (Italy) Electric Railroad. C. L. Durand. Illustrated description of a standard-gauge, single-phase system used on a line connecting

Bergamo with San Giovanni Bianco, a distance of about twenty miles. 4000 w. Elec Rev, N Y—June 22, 1907. No. 85210.

London.

London United Electric Tramways. Historical account of the development of Sir Clifton Robinson's enterprise, with illustrated detailed description. 7500 w. Tram & Ry Wld—June 6, 1907. No. 85167 B.

London Tubes.

The Charing Cross, Euston & Hampstead Railway. Illustrated description of this new line, "the last link" in the system of underground tube railways in London. 2000 w. Elect'n, Lond—May 31, 1907. Serial. 1st part. No. 84885 A.

Motors.

Calculation and Examination of the Characteristic Curves of Direct- and Alternating-Current Series Motors with Regard to the Requirements of Electric Traction (Vorausberechnung und Beurteilung der Charakteristischen Kurven von Seriemotoren für Gleichstrom und Wechselstrom hinsichtlich der Bedürfnisse der Elektrischen Traktion). W. Kummer. Mathematical paper. Ills. Serial. 2 parts. 4500 w. Schweiz Bau —May 18 and 25, 1907. No. 84965 each B.

Recent Improvements in Motor and Control. Clarence Renshaw. Read before the N. Y. State St. Ry. Assn. Considers interpole motors, unit switch control, and the single-phase system. Ills. 5000 w. St Ry Jour—June 29, 1907. No. 85369.

Recent Improvements in Motor and Control. G. H. Hill. Read before the N. Y. State St. Ry. Assn. Considers various points of improvement in design. 3000 w. St Ry Jour—June 29, 1907. No. 85368.

Power Plants.

New Power Plant of the Central Pennsylvania Traction Co. at Harrisburg, Pa. A new plant of about 2,000 kw. capacity is illustrated and described. 2000 w. Eng Rec—June 8, 1907. No. 84854.

New Power Plant of the Pittsfield Electric Street Railway Company. This steam-driven power station is illustrated and described as an interesting example of standard reciprocating engine practice for operating a small system economically. 2000 w. St Ry Jour—June 22, 1907. No. 85208.

The Electricity Generating Station of the Great Eastern Railway Co. Illustrated description of the power station at Stratford, Eng., and of its equipment. 2500 w. Elect'n, Lond—June 7, 1907. No. 85106 A.

Preston, England, Electric Railway Run by City Refuse. Frank C. Perkins. Illustrates and describes an interesting destructor installation which generates steam for the supply of the electric tramway department of the municipality. 2500 w. Elec Rev, N Y—June 8, 1907. No. 84845.

Rolling Stock.

The Law of Economical Proportion as Applied to Tramway Rolling Stock. William R. Bowker. Deals with the numerical proportioning of different types and sizes of tramway cars. 2000 w. Cassier's Mag—June, 1907. No. 85182 B.

Shops.

New Shops and Shop Practice of the Omaha & Council Bluffs Street Railway Company. An illustrated account of these shops and the practice in them. 2500 w. St Ry Jour—June 22, 1907. No. 85207.

Single-Phase.

The Single-Phase Railroad of the Brembana Valley (Italy). E. A. Kerbaker. Illustrated detailed description of this new line and its operation. 2000 w. Elec Rev, Lond—May 31, 1907. No. 84882 A.

Stations.

Report of the Cambridge Subway Stations. Abstract of an exhaustive report submitted by William Barclay Parsons upon the question of station locations. 2500 w. St Ry Jour—June 15, 1907. No. 85066.

Systems.

A Comparison of Electric Railway Systems (Vergleich Elektrischer Bahnsysteme). H. M. Hobart. Compares the efficiency of direct-current and single-phase, alternating-current systems. Curves. 4400 w. Elektrotech u Maschinenbau—May 12, 1907. No. 84976 D.

Three-Phase.

Notes on Three-Phase Traction. Gerard B. Werner. Discusses the electrification problem in general, the structural features of the three-phase locomotive, speed control, etc. 4000 w. Sch of Mines Qr —April, 1907. No. 85021 D.

Tracks.

Track Reconstruction in San Francisco. Illustrates and describes the standard track now being built, and some of the labor-saving methods that have been employed in the work. 1400 w. Elec Ry Rev—June 1, 1907. No. 84726.

Trolley.

The Bow Trolley. Gerald Hooghwinkel. Refutes remarks by Eugen Eichel in an earlier article, and explains advantages of the bow. 1200 w. Elec Rev, Lond—June 7, 1907. No. 85101 A.

Trunk Lines.

Electric Trunk-Line Operation (Der Elektrische Vollbahnbetrieb). Ph. Pforr. Discusses principally 'the Prussian and Hessian State Railway. Ills. 7500 w. Glasers Ann—May 15, 1907. No. 84958 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *b-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.

Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Klik. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

Note—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to The Engineering Magazine.

Architects' Directory.

The Architects' Directory and Specification Index. Compiled by William T. Comstock. Size, 10 by 7 in.; pp., 179. Price, $3. New York: William T. Comstock.

The eighth annual edition of this work. It contains a complete list of the architects in the United States and Canada, classified by states and towns, and the names of the officers and locations of the different architectural associations in the United States; a complete list of landscape and naval architects of the United States and Canada; a list of the building departments of the leading cities, with the names of the principal officers; together with a specification index of prominent dealers and manufacturers of building materials and appliances. The book has been carefully revised and in several departments this edition gives much fuller information than its predecessors.

Automobiles.

Self-Propelled Vehicles. By James E. Homans. Sixth edition, revised and enlarged. Size, 8 by 5 in.; pp., VII, 598. Ills., 500. Price, $2. New York: Theo. Audel and Company.

In undertaking the revision of this popular work for the present edition, the author has striven to meet the requirements of the motor-vehicle owner, operator and repairer. As stated in the preface, it would be impossible to completely review the whole field of automobile engineering in a single volume, and the present work "essays to discharge the function of a general introduction; a convenient guide book to the intricacies that must inevitably be encountered; a summary of the facts and principles that it is necessary to understand." The author has confined himself to the consideration of only the practical aspects of motor vehicles of all powers, to the discussion of matters fundamental in construction and management. Theoretical matters, of interest almost wholly to designers and builders, have been omitted except in cases where they are positively essential to a correct understanding. The principles of all the accessory parts of the automobile, igniters, carbureters, etc., are explained and illustrated by typical examples. The book with its large number of illustrations should prove of great value to the practical man and to the student of this branch of mechanical engineering.

Fireplaces.

Rumford Fireplaces, and How They Are Made. By G. Curtis Gillespie. Size, 8 by 5 in.; pp., 200. Ill. Price, $2. New York: William T. Comstock.

A reprint of Count Rumford's essay on fireplace construction, which still remains the standard work on the subject, introduced by a plea for a more general consideration of the form and proportion of this much neglected feature of building construction. The large number of excellent illustrations in the book make it of interest to the layman as well as to the architect.

Gas Engines.

Questions and Answers from *The Gas Engine*. Size, 7 by 5 in.; pp., 274. Ill. Price, $1.50. Cincinnati: *The Gas Engine* Publishing Co.

This little book has been compiled from the "Answers to Inquiries" column in *The Gas Engine,* and consists of the most interesting and valuable inquiries which have appeared in that journal during the last eight years. The inquiries have come almost entirely from men in actual charge of plants and the answers to them have, therefore, considerable interest and value for the practical man. The questions cover points relating to the design, construction, operation and repair of gas and gasoline engines for stationary, marine and automobile use, and also to gas producers. Probably the most valuable part of the book is the section on gas-engine troubles, in which many obscure points in gas-engine operation are cleared up and the cause of many of its annoying and troublesome tricks are briefly but clearly explained.

Machine Tools.

Modern American Machine Tools. By C. H. Benjamin. Size, 9 by 6 in.; pp., XIX, 320. Ills., 134. Price, $5 New York: E. P. Dutton and Company.

The author has endeavored to produce a book of value to the buyer and the manufacturer of machine tools rather than to the apprentice or the journeyman. Instead of describing details of adjustment and operation, therefore, the book is concerned with the design and construction of the machines themselves. The object has been to give the prominent characteristics of modern tools as now manufactured in the United States, the various points in which they differ from one another, and recent data as to their capacity and performance. The manufacturer of metal-working machinery will find the work one of interest and profit as showing the general trend of machine design and the more recent developments. Special machinery, such as is used for but limited lines of manufacture, has been excluded from the book, but planing, turning, boring, milling machines, in fact, all machines which would find use in a general machine shop, are fully and interestingly treated. The large number of excellent illustrations adds greatly to the clearness and value of the work.

Plumbing.

Modern Plumbing Illustrated. By R. M. Starbuck. Size, 10½ by 7½ in.; pp., 392. Plates, 55. Price, $4. New York: The Norman W. Henley Publishing Company.

An outgrowth of a series of plumbing charts published by the same author in 1899 and again in 1900. In their original form these publications consisted of seseries of blue prints illustrating various features of plumbing work and contained no letterpress whatever. For the present volume, new charts have been made, embodying the latest practice, and the value of the work has been greatly increased by the addition of several pages of descriptive matter to each chart. The work is designed to cover the whole field of plumbing as far as possible. The subjects considered range from the connections of fixtures and all other detail work to complete arrangements for all classes of public and private buildings in both town and country districts. Many tables are introduced, giving sizes and working data for all classes of work, and the final chapter, on "Suggestions for Estimating Plumbing Construction," rounds out a book which should be of great value to both the master plumber and the mechanic or apprentice.

Recipes.

Henley's Twentieth Century Book of Recipes, Formulas and Processes. Edited by Gardner D. Hiscox. Size, 9 by 6 in.; pp., 787. Ills., 25. Price, $3. New York: The Norman W. Henley Publishing Company.

The ten thousand formulas contained in this book have been compiled with a view to meeting the needs of the mechanic, artisan, manufacturer and housewife. The composition and preparation of nearly every substance used in any of the arts and manufactures are described and explained, together with those of a large number of substances of daily use in the household. Great care has been taken to include only recipes of known and tested value, and the compiler has drawn his information from the most authoritative sources available. The material is most conveniently arranged for ready reference. The subjects have been arranged in alphabetical order and the liberal use of cross-references makes the finding of information on any desired subject an easy task. Illustrations have been used wherever necessary to give a clearer idea of the subject under discussion. The entire policy of the editor has been to produce a book which might be considered "a repository of expert advice on every subject of technical importance."

BOOKS RECEIVED.

Report of the Commissioner of Public Roads, State of New Jersey, 1906. Size, 9 by 6 in.; pp., 176. Ills. Trenton, N. J.: Office of the Road Commissioner.

The Traveling Engineers' Association: Proceedings of the Fourteenth Annual Convention held August 28, 29, 30 and 31, 1906, at Chicago, Ill. Size, 9 by 6 in.; pp., 414. Oswego, N. Y.: Published by the Secretary.

Mineral Resources of the United States, 1905. Published by the United States Geological Survey under the direction of David T. Day. Size, 9 by 6 in.; pp., 1403. Washington, D. C.: Department of the Interior.

Twentieth Annual Report of the Interstate Commerce Commission, 1906. Published under the direction of the Commission. Size, 9 by 6 in.; pp., 194. Washington, D. C.: Government Printing Office.

British Standard Specifications for Ingot Steel Forgings for Marine Purposes. Prepared by the Engineering Standards Committee and edited by the Secretary, Leslie S. Robertson. Size, 13 by 8 in.; pp., 10. Ills. Price, 2/6. London: Crosby Lockwood and Son.

British Standard Specifications for Steel Bars (for Use in Automatic Machines). Prepared by the Engineering Standards Committee and edited by the Secretary, Leslie S. Robertson. Size, 13 by 8 in.; pp., 13. Ills. Price, 2/6. London: Crosby Lockwood and Son.

Second Report of the Locomotive Committee on Standard Locomotives for Indian Railways. Prepared by the Engineering Standards Committee and edited by the Secretary, Leslie S. Robertson. Size, 13 by 8 in.; pp., 6. Plates, 13. Price, 10/6. London: Crosby Lockwood and Son.

Bound before page 894

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THE ENGINEERING MAGAZINE.

PUBLISHED MONTHLY. **140-142 Nassau Street, New York, U. S. A.**

AUTHORS AND PAPERS FOR SEPTEMBER, 1907

MORRELL W. GAINES (*The Value and Economic Effect of Railway Improvements*)—Graduated from Yale University, 1898, with degree of B.A.; statistician for Brown Brothers & Co., bankers, New York.

LEWIS R. FREEMAN (*American Trade Opportunities and Handicaps in South America*)—Born 1878, in California; educated at Leland Stanford Jr. University; has just completed a three and one-half years' tour of the world, including six months in the South Seas, fourteen months between Australia, South Africa, and Europe, and eighteen months in the countries of South America, six months of this being in Argentina.

P. H. ASHMEAD (*The Railway Development of the Philippines*)—Graduated from Lehigh University, 1888, and was engaged in survey and construction work, chiefly railroad, until 1893; then connected with the Sanitary District of Chicago as sub-engineer of construction on the drainage canal until 1897, when he became chief of party under the United States Deep Waterways Commission, engaged in reconnoissance and stream measurement on the Hudson and Niagara rivers and in the Province of Quebec; 1898-1901, locating and division engineer on the Guayaquil & Quito Railway, Ecuador; 1901-1902, similarly employed on the central division of the Cuba Company's railway lines; in 1902 was associated with the Canton-Hankow Railway as principal assistant engineer; in 1903 became chief engineer of some 300 miles of railway reconnoissance across the Panhandle of Texas, and later consulting engineer on the Seaboard Air Line; re-entered the service of the American-China Development Co. in 1904 as chief of the technical department, with headquarters in New York, and was appointed engineer-in-chief of the Canton-Hankow line in 1905. Early in 1906 Mr. Ashmead was appointed secretary of the Philippine Railway Co.

WILLIAM O. WEBBER (*The Comparative Cost of Steam and Hydro-Electric Power*)—Born Springfield, Mass., 1856; educated in public schools of Manchester and Portsmouth, N. H., and in New York City. Mechanical Engineer, 1875, Toledo, Peoria & Warsaw Railway, Peoria, Ill.; engineering representative, 1876, Centennial Exhibition, Chapman Valve Co., and assistant in turbine tests; engineer of tests, 1876-81, Chicago, Burlington & Quincy R. R., Aurora, Ill.; superintendent, 1881-82, Allen Paper Car Wheel Works, Pullman, Ill.; superintendent and partner, 1882-87, Lawrence Machine Co., Lawrence, Mass.; general superintendent, 1889-94, Erie City Iron Works, Erie, Pa.; at present consulting engineer in Boston, Mass.; is a member of the American Society of Mechanical Engineers, and Boston Society of Civil Engineers, and an associate member of the United States Naval Institute.

H. L. WHITTEMORE (*Graphical Wall Records for the Production Department*)—Born in Milwaukee, Wis., in 1875 and was educated in the schools of that place; spent several years as apprentice and machinist in shops in his home city and in Hartford, Conn.; in 1900, entered the University of Wisconsin and completed the course in mechanical engineering in 1902; became assistant superintendent of the Sullivan Machinery Company of Claremont, N. H., which position he resigned in 1905 to act as assistant to A. P. Hanson of Berlin, Germany, on experimental laboratory work; in 1906 was employed in systematizing in the Control Division of the British Westinghouse Electric and Manufacturing Company, Manchester, England. Is at present instructor in the laboratory of applied mechanics of the University of Illinois.

D. C. NEWMAN COLLINS (*The Design and Construction of Industrial Buildings*)—A consulting engineer and architect, with wide experience in the design and superintendence of the structural part of many important buildings, including the Mather building, Cleveland, Betz building, Phila., Amphitheatre roof, Madison Square Garden, N. Y. World building, Lawyers' Title building, Dun building, Siegel-Cooper building, and Clearing House, N. Y., Charleston post office, S. C., and many bridges, piers and smaller structures. In industrial plants he has designed and managed the construction of Milliken Bros.' Brooklyn plant; the Atlas Cement plant at Northampton, Pa.; the mill building of the Union Iron Works and the Ewa sugar mill, Honolulu; extensive additions to the plant of the Warren Foundry & Machine Co., Phillipsburg, N. J.; structural parts of the Lehigh Valley repair shops, Sayre, Pa.; the new plant of the Pneumatic Signal Co., Rochester, N. Y.; the erecting shop of the De La Vergne Machine Co., N. Y.; and the ten-acre plant of the Lidgerwood Mfg. Co., Waverly. Some of these are reinforced concrete, some brick and steel, and a few of timber. He is a member of the A. S. C. E. and is registered as an architect.

CHARLES U. CARPENTER (*Profit Making in Shop and Factory Management*)—A graduate of Princeton University with the degrees of mechanical and electrical engineer, has had a large experience in mining engineering and electrical manufacturing and in the supervision of large manufacturing plants; for some years he was factory supervisor and afterwards head of the labor department of the National Cash Register Company, Dayton, Ohio, U. S. A. Later took a similar position with the Herring-Hall-Marvin Safe Company, rising rapidly to the presidency of the concern.

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THE VALUE OF RAILROAD IMPROVEMENTS.

By Morrell W. Gaines.

When so much is being said loosely of the "valuation of American railways" it is of real miportance and value to gain a clearer idea of the character of the problems it presents and the mode of their solution. The field of engineering economics involved is one of the most interesting belonging to our times, and one inviting more students than have yet taken it up. To its fuller understanding we believe Mr. Gaines' analysis and ably expressed argument will lend material aid.—THE EDITORS.

IN one respect the work of Wellington in formulating his analysis of railroad economics has been a detriment to the free evolution of the science. He did it too well. So great has been the esteem inspired by his deep knowledge and clear vision that his conclusions, in many cases, have continued to hold authority long after the crumbling of the foundation of fact. The metamorphoses of time bring a continual need for fresh analysis. Wellington's great figure has barred the way. Men have lacked the temerity to undo, or to seem to do over again, what he had done so well. As a result the point has now been reached when there is, for practical utility, more to be altered in his conclusions than remains valid within them. His elucidations of principle will always stand as models of inestimable worth. But the superstructure he builds thereon has somewhat lost its application.

In no branch of the science does this stand out more clearly than in the economics of railroad improvements. Wellington's treatment here is light at best, because under the conditions of the time when he wrote, the order of the day was new construction rather than the betterment of existing lines. Extensive development had even then progressed to the point where it necessitated some intensive development, but not at all to the degree now observable. The improvement policy was then a rill where now it is a mighty river. Within a few years, during the heavy traffic period that began with 1898, the great systems have each spent tens, and in some cases hundreds, of millions of dollars on betterments. In view of the preponderant, and still growing, importance of the problems of reconstruction, what Wellington has to say about them is all too little. What he does say is not, as it stands, applicable to the changed conditions of the times.

When his work on Railroad Location first appeared, thirty years ago, and even at the time of the revision of 1887, the structure and equipment of railroads were altogether of an order that has passed away. The general adoption of the heavy steel rail, and the introduction of steel and concrete bridges, have brought a new type of track, whose strength is greater than he could have foreseen. The air brake, the automatic coupler, heavier equipment, and the tonnage rating, have given a larger unit of load than he had the opportunity to observe, or could have prophesied. Traffic is denser and the cost per ton mile of haul is less than it was. Finally, on top of the change in all the physical elements of the situation, the fall in rate of interest has altered the relation between carrying cost of new investment and prospective decrease in operating expenses to be secured therefrom. In all respects, therefore, the terms of his problem need restatement.

Individuals have from time to time essayed the reshaping of details, or even of considerable portions of the sum total of the analysis. Much has been done in a preliminary way by those who, like Mr. J. B. Berry after the reconstruction work on the Union Pacific, have given us the rough-hewn synthesis of old and new conclusions used by them as a working hypothesis in meeting their own practical exigencies. But the colossal labor of recasting the whole science of improvement economics *de novo* has remained for the American Railway Engineering and Maintenance of Way Association to take up. That work has only just got under way and it will probably be some years before definitive results are reached. It is with a true sense of its inadequacy, while yet realizing the importance of the book as a contribution to railroad knowledge, that we turn to Professor Walter Loring Webb's recently issued "Economics of Railroad Construction" for a perspective, and a proper viewpoint, in the cursory examination of the accrued deficiencies of Wellington's principal conclusions. The work in question rests on the foundation of the older book, modified by the observations, experiments, and statistics of the twenty years that have elapsed, and to a certain extent by the clear reasoning powers and ripe experience of its author. It is an excellent compilation and as typical, perhaps, of the existing state of knowledge of the subject as was Wellington's Railroad Location in its day. While not at all to be taken as final or rigorous in its demonstrations, owing to the insufficiency of its experimental basis, it is as nearly final and complete as anything we now have. It will, accordingly, serve as a valid basis for contrast and comparison.

In painting any kind of picture it is not the details but the general composition that conveys the meaning and is the vital essence of the whole. So in describing the relation of improvements to the railroad the important thing is to portray the co-ordination of the main elements, and to show broadly the principal factors of the problem in their proper proportions. Detail must be sacrificed. The treatment, therefore, will be quite simple. No reference will be made to that large class of improvements, such as those to curves, signals, and terminals, which have not for their prime object the increase of the freight-train load. The problem of terminals, which more than any other one influence have come to be the limiting factor in railway growth, is, without doubt, of the very first importance; but it is always an individual problem and not adaptable to the conditions of a general comparison. The freight-train load, on the other hand, is a common divisor of great power with reference to the bulk of both Wellington's work and Webb's—and indeed, to the whole question of improvements in its more general aspects.

Improvements that allow increase in train load earn money by decreasing the number of train miles. The amount a given improvement will earn now as compared with what it would have earned when Wellington wrote depends, therefore, in the main, (a), upon the change in the normal number of trains due to the growth of traffic since that time; (b), upon the change in train-mile expense.

To a certain extent the change in the normal number of trains brings into the argument the history of what has already been done by the average road in the way of improving itself and increasing its train load. For that reason a short *résumé* of the course of traffic and operating conditions since the early eighties is essential as a foundation for the further discussion. The following table, compiled from approximate figures in Poor's Manual for the first three periods, and taken from the Interstate Commerce Commission Reports for subsequent years, shows the change in freight-train miles per mile of line and, as well, the decrease in rates, advance in train load, and increase in traffic density.

Railroads of the United States.

Year.	Miles Operated.	Freight-Train Miles.		Ton Miles of Freight Hauled.		Rate per Ton Mile, Cents.	Tons per Train.
		Total.	Per Mile.	Total.	Per Mile.		
1882	95,752	305,118,035	3,187	39,302,209,249	410,458	1.236	129 (approx.)
1885	122,210	342,288,770	2,808	49,151,894,469	402,192	1.057	144
1890	157,976	482,900,422	3,056	79,192,985,125	505,095	.93	165
1895	177,746	449,291,238	2,527	85,227,515,891	479,490	.839	189
1900	192,556	492,543,526	2,558	141,596,551,161	735,352	.729	271
1905	216,975	546,424,405	2,519	186,463,109,510	861,396	.766	322

From the standpoint of the larger strategy of railroad building and railroad improvement this table compresses within its few lines the whole story of the fall of the period of extensive development and of the rise of a period of intensive development. It shows, clearly and simply, the ruinous financial pressure created by an expansion beyond what the traffic, and the population, would bear, and the relief that has come as a consequence of converting available resources into improvements instead of new construction.

Until shortly before 1900—1899, to be exact—freight rates declined under a fierce competition for tonnage. Until after 1895, ton miles of freight per mile of road remained practically stationary. Both of these results were, directly and indirectly, consequences of too rapid growth. As for operating conditions, the period of improvements not having strongly set in, train load showed but a moderate increase and the ton of freight had to bear a larger proportion of the train expenses than was warranted by the heavily decreased rate per ton mile. From this combination of circumstances—thin traffic, low rates, and high expenses, not to speak of the interest charges of those days—receiverships followed as a matter of course.

After the ruin came the time of repentance, of a strong reaction from the disastrous expansion policy of the preceding twenty years. With the return of confidence there was an abundant supply of capital, the accumulation of several years of forced economy and curtailing of enterprise, awaiting the needs of the railroads at low rates of interest. More than ever before it was within the power of the railroads to choose their course and to build the future according to their will. By one method or another, from the community of interest of the powerful to the lack of aggression of the weak, the railroads of the United States showed that the lesson of defeat had sunk home. New construction, while still active enough to meet the constant need for a living growth, became now very moderate in proportion to the extent of the already existing mileage. The offensive policy of expansion gave place to the defensive one of betterments.

During these ten years of the new era the change in track and equipment has so far progressed that the average train load has been practically doubled. The influence of the betterment policy is felt in many directions. Rates are better maintained, for a number of reasons to be sure, but fundamentally because the slackening of new construction has allowed traffic to become so thick that it does not need to be scrambled for. The increase of more than 100 per cent in the total volume of freight traffic, from 85 million ton miles in 1895 to 186 million in 1905, is little more than a continuation of the previous rate of increase. But the growth in traffic density from 479,490 ton miles per mile of line to 861,396 ton miles is a complete change, and one that is, probably, unprecedented in the history of American railroading. For from 1895 to 1905 the increase in railroad mileage was only 20 per cent, as compared with 41 per cent in the preceding ten years, 73 per cent from 1875 to 1885, and 95 per cent to 300 per cent in the four previous decades. Since 1895 the pioneer process of building roads to create traffic has been given up in favor of the effort to take care of the traffic that offers on existing lines.

Facilities have been adapted to the doubled density of freight movement, to such effect that there has been an actual decrease in train miles per mile required to carry it. Transportation has been made cheaper. The present great tonnage moves with profit at rates that would not have paid the bare operating expenses in Wellington's time, and that are measurably lower than those which brought bankruptcy twelve years ago. The betterment policy, the making of better lines rather than more lines, has proved itself a necessity to the vital energies of the railroad companies.

Going back now to Wellington: it is apparent that very little alteration is to be made in the valuation of improvements on the score of change in frequency of freight-train movement. Increase in unit of load has kept close step with increase in volume of traffic, so that the number of trains run has remained nearly constant. In individual cases the practice has, of course, varied a great deal. Comparison between the Atlantic Coast Line and the Great Northern, or even between St. Paul and Búrlington, would show a wide divergence in the trend of the train-mile density. But on the whole it is to the train-mile expense rather than to the number of trains that we must look for change in the earning power of improvements.

Wellington and Professor Webb approach the subject with forms of analysis similar enough to afford essentially comparable results. Each gives detailed calculations of the value of grade reduction and of the use of powerful locomotives, and each bases his conclusions on the number and cost of the train miles saved. By rearrangement and condensation the following approximately correct comparison can be given of the tables they use as a starting point in discussing the economics of grade reduction:

Percentage Table—in Terms of the Cost of the Average Train Mile.
Cost of One Additional Train Mile Due to Grade.

	Wellington. Per Cent.			Webb. Per Cent.		
	Normal.	Affected.	Added.*	Normal.	Affected.	Added.*
Maintenance of Way..	23	76.1	17.5	21.034	16.8	3.531
Maintenance of Equipment	17.6	17.3	3.	18.024	25.1	4.514
Conducting Transportation, Unapportioned General Expense	59.4	46.	27.3	60.942	71.7	43.712
Total	100.	....	47.8	100.	....	51.757
Interest on Cost of Locomotive	.....	....	1.7	....	....	1.5
Total added cost	.....	....	49.5	....	....	53.257

Professor Webb having confined himself to operating costs, the "Interest on Cost of Locomotive" figure is an interpolation in his table to put the two final results on all fours. Thirty per cent of Wellington's total is "un-apportioned," or non-conformable to the Interstate Commerce Commission classification, and a small portion of that amount should by rights be distributed to the Maintenance of Way and Maintenance of Equipment accounts.

There is a conspicuous difference in the "Per Cent Affected" and "Added Cost" under Maintenance of Way. It is due to a difference in opinion more than to any real alteration in the basic facts. The subject of the relation of the number of trains to the amount of maintenance of way is one that has not been, and, from its nature, perhaps cannot be thoroughly investigated. The weight of the probability seems to incline to the more recent view expressed by Webb. If he is right, that particular method of grade reduction which consists in building a detour, leaving the old track in partial operation, is not nearly so profitable as it would be under Wellington's hypothesis, which is still, in effect, quite generally followed. According to Webb's view the maintenance of the old track would not be diminished by the removal of trains from it to anything like the extent assumed by Wellington.

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* That is, per cent of the normal average cost attaching to the additional train.

The two totals of 49.5 per cent and 53.257 per cent agree more closely than would be expected considering the lapse of time and change in operating conditions. It is possible that a thoroughly fresh analysis, one entirely removed from the shadow of Wellington's influence and resting solely upon an experimental foundation, would show a more radical departure. Wellington applied his percentages to an assumed train-mile cost of $1.00—the actual average for revenue trains in 1888, a year after the revision of his book, being $0.96. His figure is conservatively high. Professor Webb puts the operating cost at $1.30, the 1904 average. For 1905 the Interstate Commerce Commission reports it at $1.32, and for 1906 Slason Thompson's compilation gives $1.387. Considering the rise in all classes of expense it would be conservative to call it $1.40 at the present time. This is particularly true in view of the fact that the large freight train probably costs more, all things considered, than the passenger train. Adopting the figures of $1.00 and $1.40 respectively, there is according to Wellington an economy of 49.5 cents per train mile saved; according to Webb (as revised) 74.56 cents, an increase of 50.6 per cent. On one daily train each way saved by grade reduction the economy (for a 100-mile division and year of 365 days) would be $36.135 and $54.429 respectively. Wellington capitalized expense at 6 per cent or 7 per cent, where now 4 per cent or 5 per cent would be sufficient. Then we have the following comparison:

Capitalized Value of a Grade Reduction Allowing the Same Traffic to Be Handled by One Train Less per Day Each Way on a 100-Mile Division.

	Based on Wellington.		Based on Webb.	
Capitalized at	6 per cent.	7 per cent.	4 per cent.	5 per cent.
Value	$602,250	$516,214	$1,360,725	$1,088,580

The value of a given grade improvement has, on the whole, more than doubled since Wellington's calculations were made. Yet his observations, and even those of an earlier day, are still in effect on many old lines, owing to the inertia of reconstruction. More than that, in spite of attempts to adapt locating work to conditions, they are often employed just as they stand, except for the interest rate, in laying out new lines, and in determining the character and extent of grade revisions. It is common practice to utilize a part, and that generally a major part, of his conclusions.

Discipline and technical training have brought the generality of railroad operations up to a high degree of efficiency. The practical working out of grade economics has not as a rule been attended to with the same degree of skill and completeness. That is not because the matter is complex, for it is essentially simple. But it is of a nature outside the scope of the tactics of railroading which discipline and skill have perfected. It belongs to the higher sphere of management, where success makes requisition alike upon individual initiative, co-operation of directors, good credit, and favoring circumstances. The comprehensive reconstruction of a railroad falls, after all, within the day's work of comparatively few men. Of those still fewer have the free hand and the sense of proportion to work out their improvement policy, even for the moment, into a well rounded whole.

Any road could absorb a practically unlimited amount of capital in improvements before being brought to physical perfection. A part only of the expenditure would be profitable, however, under actual conditions, and of the profitable improvements some would earn more than others. A line improved up to the profitable limit in Wellington's time would have done all work that promised a yield of 6 per cent or 7 per cent, and left undone everything beyond that point. If now this same road were to be reimproved, it would be probable that a large amount of expenditures would be encountered that would have yielded a trifle less than 6 per cent or 7 per cent in those days, and which at the present time, from the comparison above, would accordingly yield 9 per cent or 10 per cent. Construction work is often cheaper than it used to be because of the steam shovel and the locomotive haul. There are, too, many lines in operation which are not properly laid out, even according to the methods and conditions of Wellington's time. Besides, there are usually, in the case of a road which has fallen behind, one or more special imperfections which act as limiting faults to increase the number of trains or to curtail the traffic. Consequently, in instances by no means rare, a very abnormal return is to be obtained on a moderate and judicious investment in line improvements. And on all roads there is a good profit in a constant evolution towards a greater efficiency of track than can be gained by following Wellington.

In comparing the calculations given by the two authors for the value of increasing the tractive power of the locomotive, more difficulty is encountered than in the case of grade reduction. The subject is one whose importance had hardly begun to be appreciated twenty years ago. There was not then the variety of types of engines to choose from that there is now. Wellington, in approaching the discussion, offers a table showing the increased cost of running larger locomotives, to be combined with the statement already cited for the economy from reducing the total number of train miles, in order to get the net saving of the more powerful equipment. The added cost for a locomotive of doubled weight is 14.1 per cent of the normal train-mile expense. This figure may probably be assumed to vary with the increase of weight of the engine. For comparison with the statement which Professor Webb gives, showing the economy of handling the same traffic with three engines instead of four, the assumed increase in weight of the locomotive may be taken as about 40 per cent, giving an added cost of 5.6 per cent in terms of the normal train mile. Subtracting this from the 47.8 per cent gross economy per train mile saved, there is left 42.2 per cent as the net economy by use of the heavier power. Professor Webb gives 44.787 per cent.

With a train-mile cost of $1.40, Webb's percentage gives a saving of 63 cents for every train mile eliminated. According to Wellington the economy is 42 cents, or just two-thirds as much. A very liberal allowance of a cent per train mile run to cover the capital cost of old engines thrown away would bring the figures down to 60 cents and 39 cents respectively. On an engine running 30,000 miles a year, and saving 10,000 train miles, the annual economy above all expenses, including renewals and capital charges, would be $6,000 and $3,900 respectively. The incentive to increase power as far, and as fast, as the track will stand it has been considerably heightened since Wellington wrote. It was not, however, then a matter that admitted of intelligent dispute. Engines hauling through freight must necessarily be of the most efficient type procurable. The capital cost of the investment in rolling stock is practically a negligible quantity. Where, however, heavy improvements to bridges and road bed are also involved, the same conclusion is to be reached as in the case of the reduction of the ruling grade. The investment should be expanded, under like circumstances, to twice the scale permissible under the calculations of twenty years ago.

There is a general law governing the return on investments referred to by Mr. Jacob H. Schiff two years ago in his testimony before the Committee of the United States Senate on Interstate Commerce. It is to the effect that the average return over long periods on money invested in enterprise, and particularly in railroad enterprise, tends to follow closely the rate of interest at which money can be borrowed for investment. The competition of capital, whether it be expressed through the laying down of steel rails, or through the mechanism of the common markets for the freight carried, for wages paid and materials bought, acts as a great leveler of unearned, and undue, profits. Save where the original location brings a preferential advantage indisputable from any source, the only way by which a higher than average degree of profit may be assured to a railroad is through the employment of a higher than average degree of skill and intelligence in meeting its operating and engineering problems. It must keep in the forefront of the advance made by roads of its own situation and class, and particularly in all that pertains to physical fitness. It has been shown that the return on properly proportioned improvement expenditures, made over and above what is indicated by Wellington's calculations, tends to be in excess of the rate of interest on the money invested. Per contra, the present rate of return on the money originally invested according to those calculations tends to be less than the rate of interest. For the roads which have attained the highest economy in operation are constantly giving back a part of the results of their efficiency to the public in the form of lower rates and better facilities. This is a corollary of the same universal law, and it penalizes the roads whose efficiency has fallen below the average.

It is for this reason that roads which rely solely upon their original investment are at a disadvantage in spite of low capitalization. It is for this reason that roads like the Southern and the Erie, which have endeavored to modernize themselves, but with insufficiently lavish outlay, have a long, uphill struggle against high operating costs and low net earnings. It is for the same reason, again, that heavily improved or recently constructed lines like Pennsylvania, Union Pacific, and Great Northern, get the utmost out of the prosperity around them, which they themselves have in large measure created. With little apparent effort they go on into an ever strengthening position of power. Improvements are the key to profit in railroading. The need for more, and still more, improvements is insatiable, wrapped up as it is with the development not only of the railroads themselves but with that of the country as a whole. For that reason the casting away of what is now dead in Wellington's admirable analysis and the reshaping of the rest to fit the new problems of the times is a matter of supreme importance.

AMERICAN TRADE OPPORTUNITIES AND HANDICAPS IN SOUTH AMERICA.

By Lewis R. Freeman.

Mr. Freeman's article is the fruit of eighteen months of observant travel and study in South America, six months of it in the Argentine Republic. American himself, and thoroughly loyal in sympathy, he is frank and impartial in expressing his conclusions, whether favorable or not to national self-gratulation. It is clear that direct but friendly criticism such as this is the very best help in changing past mistake to future success.—The Editors.

THERE seems to be a very general idea in the United States that, since the visit of Mr. Root to South America, the country has but to step in and reap commercially the fruits of the harvest that our able and diplomatic Secretary of State sowed politically. That we should, and in time shall, supply the greater part of the wants of our southern neighbors is as undeniable to one who understands our manufacturing potentialities as is the fact that, in the light of our showing to date along this line, there has been little to lead to that conclusion one who has only watched our disconnected efforts from the outside without appreciating what is behind them. That is to say, any hopes we may legitimately entertain for future supremacy in South American trade should be based less on what we have done than on what we know we can do when the time comes. The "step in and take" idea of the man in the street is based on nothing but his fathomless American confidence, and, in this instance, an equally fathomless ignorance regarding the true conditions that prevail in the countries in question.

When the time will come for the United States to win its way to first place among the countries exporting to South America involves considerations of economic as well as commercial import. Until the United States is as congested with population as England, Germany, France and the rest of the countries figuring prominently as exporters she will not make anything like the same vigorous effort these countries are making to build up and constantly increase her foreign trade. When that time comes—unless, perchance, we have taken time by the forelock and prepared in advance—we will still have to school ourselves in the infinite details of the task of catering to the wants of a strange people—something that our rivals have spent the better part of the last four or five decades in mastering. Moreover, we must then have more American importing houses abroad to obviate the present necessity of selling our goods through German or English concerns which, very naturally, give the goods of their own countries the preference; also, American banking houses, of which there is at present not a one in South America. We must also develop and train salesmen who will master the language of the people with whom they are dealing and thus render themselves independent of interpreters, who—and this is particularly true of South America—only too often have understandings with the buyers. Further, our salesmen must give up trying to sell goods after the slap-bang North American system of "take it today for I'm off tomorrow," and accustom themselves to waiting patiently till *mañana* for orders, and then several *mañanas* after that. When all these things come to pass, and when, in addition, we are shipping our goods in fast American steamers—subsidized if need be—which will also give a swift and regular American mail service—then, perhaps, we may be able to scan the table of countries exporting to South America and find the name of the United States without running our finger down the column.

Space, and the scope of this article, will not permit a discussion of these essential "conditions precedent" I have enumerated, and only a brief amplification of one or two of them. One of our worst handicaps today is the almost total absence of large American importing houses. In the city of Buenos Ayres, with its 1,200,000 people and a trade equal to that of any four other ports of the continent, with the exception of a threshing-machine company dealing exclusively in its own products, there is not a single prominent American firm. Our goods are imported and sold principally by the big English and German houses, several of which do a larger business in American lines than in goods from their own countries. This latter fact has been due almost solely to the marked superiority of the goods—mostly argricultural machinery—rather than to any vigorous pushing they have had from the agents.

In Chile, one of the two most prominent importing houses is American; but the manager and heads of departments in the main office at Valparaiso are English, and, out of several score of clerks, only three or four are American. The Concepcion manager of the same house, and all his assistants, are English, while the Valdivia manager is Norwegian, and all under him Germans.

There are several reasons for this state of affairs, and the principal one, briefly stated, is that, until conditions in the United States force American manufacturers to seek foreign trade after the manner of their European rivals, a man with the executive capacity to be worth, say, $15,000 a year at the head of a branch abroad will be able to command twice that sum at home. With the necessity of building up a foreign trade, the value of his services abroad will continue to increase while his value at home will probably fall off, or only remain stationary at best. When, and not before, the American manager is worth more abroad than at home, the country will be properly represented commercially in foreign countries.

In the matter of salesmen we must have men who not only speak the language, but who are also thoroughly conversant with the customs and idiosyncrasies of the people with whom they deal. The South American, in his buying as in almost everything else, is a most deliberate person as well as a very sensitive one. A salesman who will call, smoke a cigarette, talk inconsequentially about the weather, the theater, and the races, and answer questions—should any happen to be asked—rather than make assertions about his goods, will outsell, five to one, the livest hustler that ever opened up a sample case. This is a thing so contrary to the very instinct of the American salesman that, to date, in his wanton disregard of it, he has constantly played into the hands of his more experienced European rivals. "Your Yankee drummers," say the later politely, "are the greatest salesmen in the world—in America."

Banks and long credits have been urged so frequently, and their necessity is so obvious, that there is nothing new to be said on the subject. As for subsidized steamship lines, the strongest argument in their favor is found in the fact that Kaiser William credits them with being the principal factor in the swift closing-in of Germany upon England in her export trade.

In the race for supremacy in South American trade, sentiment is a thing which the United States must leave quite out of the reckoning; for where sentiment exists in the southern republics it is more often unfavorable to us than otherwise. Only in Peru, Ecuador, Bolivia, and Brazil do we stand on the same basis of popular regard as our rivals. In Uruguay, Argentina, and Paraguay we are disliked, in Chile and Venezuela hated, and in Colombia, detested. In the three latter instances our unpopularity has largely arisen from specific incidents, such as the Baltimore affair at Valparaiso, and the secession of Panama; but running deeper, and pervading most of the peoples of the continent, is a more or less thinly veiled dislike of the American personality, which is the very antithesis of their own, a jealousy of American power and prosperity, and a distrust of American intentions as embodied in the Monroe Doctrine. As a result of

Mr. Root's visit some of these feelings are in temporary subsidence; but, in general, they were too deeply seated to allow much hope that they are permanently eradicated.

From the foregoing it will be seen that we still have a long road to travel, and one beset with many obstacles, before winning our way to the goal of South American commercial pre-eminence. Far from being a "step-in-and-take" proposition, there is nothing for it but to "buckle down and fight." A certain amount of racial prejudice there is always going to be against us, probably sufficient of it to offset any advantage of geographical position we now enjoy, or even those that will come with the completion of the Panama Canal. After first placing ourselves as nearly as possible on an equality with our European rivals in the matter of facilities for transporting and selling our goods, we must make our winning on the sheer superiority of the goods themselves. In certain lines—principally shoes and metal manufactures of the type-writer and cash-register class—we have already established an easy lead in spite of all handicaps, and in several other lines we are rapidly gaining ground. What has to be done to attain this success, what can be done, as well as the difficulties attendant upon the doing, are clearly illustrated in the experience of one of our largest threshing-machine companies.

Ten or twelve years ago, when these people made their first effort to introduce their machine into Argentina, that country's demand for threshers, and all other agricultural machinery, was supplied by English manufacturers with strongly-built but—in comparison with the American article—hopelessly out-of-date machines. The relative value of the most popular English thresher and the American machine in question might—and may still—be judged from the following brief data, the authenticity of which I have carefully confirmed by personal inquiry and observations in the field:

The English machine and engine weighed several thousand pounds more than the American, cost about a third more, and, under equal service, lasted about a third longer. The American machine, with half the number of men required to serve the other, would accomplish twice the amount of work in a given period. Thus, the considerations of "life" and cost practically offset each other, leaving the advantage of weight in favor of the American machine, in addition to which the greater economy and superior efficiency of the latter figured out at about four to one.

In spite of these advantages—repeatedly demonstrated whenever it had a fair trial—the American thresher languished for several years in an English importing house, which, incidentally, also sold

English machinery, and few sales were made. This was due not only to the failure of the agents to recommend it fairly, but also to the fact that a large number of the great *estancieros* of Argentina were English, and of the type of that good old Briton who swore that he would turn back from the golden gates themselves if he failed to find the Union Jack waving over them. Most of these ranchers, at that time at least, would have cheerfully gone down to failure rather than win success by using a "cute Yankee contrivance," and the Argentiños, who have a great and not unfounded respect for British judgment, displayed a similar contempt for the new machine.

After a long period of loss and discouragement, the American company, as a last resort, established a branch of its own in Buenos Aires. A number of the best machinists in its employ were sent down and every machine sold was not only set up, but also delivered, and operated for at least two weeks, under the personal direction of one of these experts. If the buyer desired, an American engineer was supplied, at a moderate cost, for the whole season. The company provided all its men with competent interpreters, but at the same time did all it could to encourage them in learning the language, while handsome bonuses were also paid those willing to renew their first season's contract and continue their work in Argentina.

Without tracing through the years the record of the phenomenal success that followed the inauguration of these radical departures, it will suffice here to say that the company in question sold last season more machines than all the English and German companies combined, and that following close behind it in the matter of sales came two other American companies which have adopted somewhat similar methods of introducing their goods. The trade of the native Argentiño in every class of agricultural machinery is now practically monopolized by American concerns, though the British ranchers, as a class, still stand gamely by their English models.

But outside of the splendid showing we are making in agricultural machinery, light metal manufactures, shoes, and a few knickknacks, there remains the whole long list—including everything imported by a rich and progressive people—in which we are hardly figuring at all; and the most important article on that list is railroad supplies, our specialty. Argentina, next to the United States (and, possibly, Russia), is destined to be the greatest railroad country in the world, and already her mileage is but little short of that of all the rest of the Southern Hemisphere combined. On every line in that country I saw, from time to time, various antiquated specimens of American rolling stock, but little that could, by any stretch of that term be characterized as modern. Having in mind the fact that the general conditions to be met by a railroad in that country are so nearly identical with those that obtain in the United States that most of the freight and passenger cars, though of English manufacture, are of American pattern, I asked a prominent railway official how it was that they were no longer buying in North America. He smiled an amused smile of reminiscence, and then told me what I have since learned is the Argentine railroad man's stock story when the subject of American rolling stock is brought up.

"I was traveling on a train in Mexico a few years back," he said, "and in an adjoining section were seated two men whom I judged from their conversation to be American railway officials. Our car was an untidy, stuffy affair of an obsolete design, commenting on which fact one of the gentlemen, after roundly rating the company for compelling people to travel in such state, ended up by exclaiming disgustedly: 'The "Central" people should have discarded such junk as this years ago; they needn't necessarily have scrapped it, but they might at least have sold it to one of the Argentine roads and got it away from civilization.' "

For the benefit of those not familiar with the lines of Argentina I will state that the joke in this, from the standpoint of the railroad men of that country, lies in the fact that their average equipment is easily up to that of the American roads.

This proclivity of Americans, not only in thought but in practice as well, to consider Argentina as a dumping ground, has done our trade more harm in the last twenty years than proper recognition can undo in the next fifty. Operative, also, in preventing the railroads from buying in America has been the fact the freights are higher than from England and the steamer service far less regular.

The circumstance that nearly all the Argentine roads are owned in England would, in any case, other things being equal, cause their equipment to be bought in that country. The point I am coming to here, however, is that I have been assured on every hand that things are not equal; that much of our rolling-stock, even when new, did not give the service of that English manufacture, and that today, between locomotives of equal age, those of England are more economical and in better condition than the American importations.

During eight months spent between Argentina and Uruguay, in which time I traveled over nearly every mile of railway line in those two countries, and talked with every class of employee and official from greaser-boy and section-hand up to manager and president, I made written note of all the opinions expressed on American rolling-stock and kindred machinery. This heterogeneous mass of evidence—most of it unfavorable—I reduced to its lowest terms by the elimination of repetition and similar criticism as much as possible, and submitted the salient points for expert comment to a gentleman whose wide experience on South American railroads makes his opinion practically authoritative on the subject in hand—Mr. P. Seagfield, locomotive superintendent of the Central Uruguay. His report, which I append herewith in all its essentials, I regard as the nearest approach to an unprejudiced comparison of English and American railway equipment as found in South America that it is possible to obtain from an English-trained railway man. Unfortunately, there are no Americans on the ground who may be consulted in the matter; hence any reply—general or specific—to the criticism which follows must come from North American railway men.

Mr. Seagfield's own experience with articles of American manufacture is fairly extensive, his road having among its rolling stock a number of locomotives, carriages and wagons which were supplied by American firms. He says in part:

"LOCOMOTIVES.—When we took over the Western Railway (in 1900), we received nine engines of American build, all of the four-wheel coupled simple type, with tenders carried on two four-wheeled bogies. Six of these had cylinders 17 by 24 inches and 5-foot 3-inch driving wheels. The remaining three had cylinders 15 by 24 inches, the driving wheels being the same size. As taken over by us the engines were all practically new, some of them not having been even erected, and we have worked them ever since, that is to say for the past five or six years, but the experience I have gained so far would not induce me to perpetuate the type in competition with English-built engines, which we much prefer.

"Some of the defects we have noted are as follows:

"ADHESIVE WEIGHT.—The engines are generally wanting in adhesive weight in relation to the size of the cylinders, and this coupled to want of stiffness in the bar frames causes a tendency to slip, especially in starting a heavy train.

"COAL CONSUMPTION.—The engines are undoubtedly heavier on coal consumption per vehicle hauled than their competitors of English build, though I have not found the difference to be so large as to hinder our making considerable use of the engines. Regarding the cause of the increased consumption, I am inclined to think that in the first place the steel fireboxes have something to do with this. All English engines are fitted with copper fireboxes, the superior heat conductivity of which is an advantage. Another cause is the greater expansive working of the steam in the cylinders in the English engines, and although I find that the American valve gear gives a fairly wide range, in the normal working position of the engine the cut-off is not so early.

"After running the engines for a short time we came to the conclusion that the orginial exhaust nozzles of the double type created undue back pressure, and we changed them for single nozzles of English type, thus considerably increasing the area, with apparently beneficial results, as while the coal consumption for six months ending June 30, 1900, averaged 1.67 pounds per vehicle-kilometre, this figure had dropped to 1.35 pounds for the six months ending June, 1905.

"GENERAL WORKMANSHIP.—We have had cases of breakdowns with these engines which according to English standards would be classified as attributable solely to defective workmanship or material. For instance, valve-stems have broken off close to the buckle, due to defective method of welding. The crossheads, which together with the small end pin of connecting rod are in one casting of iron, have given trouble owing to the small end pin breaking, and splitting has occurred through the cotter-way which secures the crosshead to the piston rod.

"AXLES.—All axles of these engines were of wrought iron and they soon developed laminated flaws, and, commencing with the bogie axles which gave out after a very short life, we have had to renew them throughout. In the case of the tenders this involved, as well, the renewal of the original cast-iron wheels by cast-steel centres fitted with hard tyres, owing to the fact that the cast-iron wheels developed flaws and flat places after a very short life.

"BRAKE GEAR.—The tender brake-gear was of very flimsy construction, the brake beams being of wood and iron flitched, and owing to its general lightness of construction we have had to renew and modify the arrangement throughout.

"SMITH'S WORK.—Generally speaking all smith's work is of a cheap and rough description and cannot be compared with corresponding work on an English-built engine. Welds are particularly badly made, and I may instance the arms of the rocking shaft of the reversing gear which, instead of being a solid forging with the shaft, are simply dabbed on.

"BOILER AND FIREBOXES.—The workmanship of the boiler is good, and leaves little to be desired, but we have found a want of uniformity in measurements. When it became necessary to renew the fire bars we found that those which fitted one engine would not go into another of the same class, owing to there being differences of upwards of 1¼ inches in length of the fireboxes in what are nominally sister engines. The trouble that this will entail when fireboxes have to be renewed will be considerable, and will, I expect, decide us to scrap the engines sooner than would otherwise be the case.

"Cylinder Castings.—These are both good in material and workmanship, but the exhaust passages, owing to their form, get water-logged, and we have found it necessary to fit automatic relief valves.

Carriage Stock.

"We have a few bogie carriages of American build which were taken over with the North Eastern Line, but they are now upwards of 30 years old and do not represent contemporary American practice. They were, nevertheless, well built, which is demonstrated by the fact that we still make use of them alongside of our more modern stock, and we have nothing today which forms an easier or better riding coach.

"Freight Cars.—We have a small number of open, flat freight cars and a few covered ones. There is nothing much to be said against these except that in the matter of the English draw and buffer gear with which they are fitted, the wrought-iron work is of an exceedingly rough character. On the other hand, I may mention that the springs appear to be exceptionally good, and I have found this to be the case whenever dealing with American springs for rolling stock. The roofs of the covered wagons were originally of wood, double thickness, the top boards overlapping the joints of the under ones, but the arrangement started to give trouble by leaking and we have since had to replace the roof boards by corrugated iron sheets.

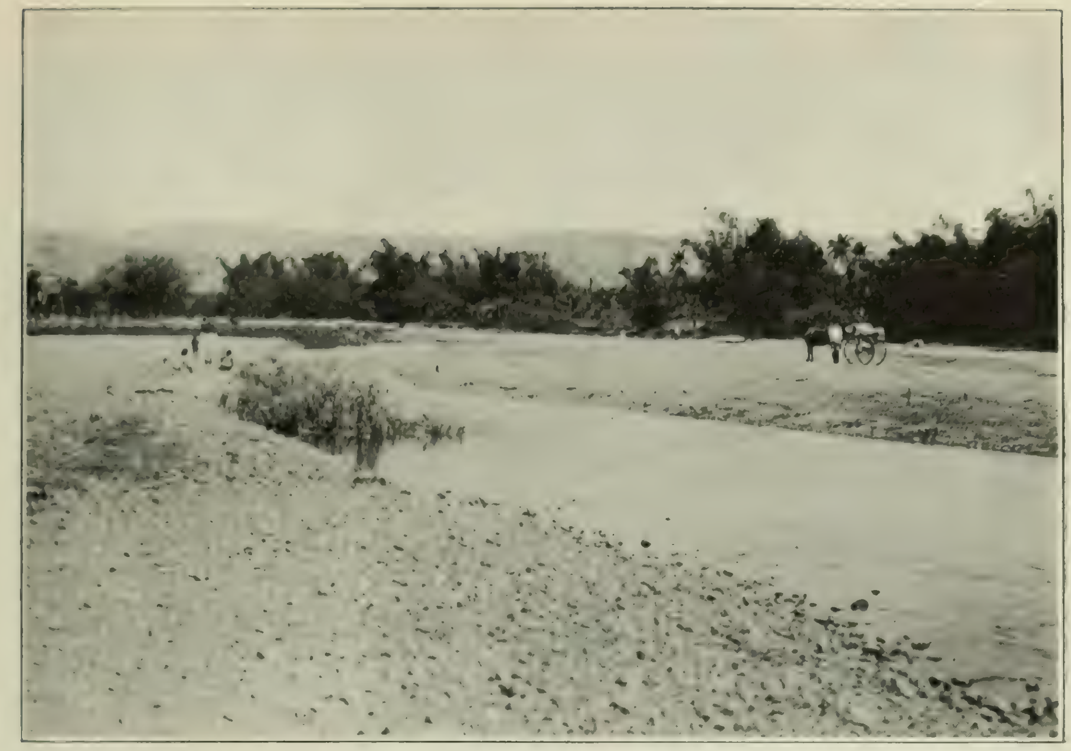
"Bolts and Nuts.—These as applied to articles of American manufacturers in general are a source of trouble when such articles are for export, owing to the fact that the size of the nuts and pitch of the threads correspond to American or Sellers' standards, whereas, outside of the States, the Whitworth's standards are those most commonly in use. The result is that, as bolts and nuts are very often the first articles which require renewal, we find that these have to be replaced by our Whitworth's standards and this often involves spanners having to be duplicated, to say nothing of the fact that possibly, when only the renewal of a nut is involved, the bolt has to be thrown away as well, owing to the difference in pitch of threads.

"Machine Tools.—I have little or no experience of these, but have no doubt that nowadays the Americans turn out some very fine machinery. As a matter of choice I should prefer Anglo-American machinery—that is to say, tools embodying American ideas, which are often very ingenious, but manufactured according to English ideas of solidity and thorough workmanship.

"WINDMILLS.—I have had some experience of these of American make during the past five or six years, but can say nothing in their favour, as they have given us endless trouble in the matter of repair and upkeep, owing chiefly to an entire want of proper provision for renewal of wearing parts and also to absence of efficient means of lubrication.

"GENERAL REMARKS.—As you will see, I have little to say in favour of American manufacturers in general, and I think the reason for this in the matter of locomotives and machinery is not far to seek. In the first place American designers of locomotives, until recently, have been conservative in their designs—it being unusual for a manufacturer to depart from his settled types—with the result that practically the same engines as used in the States have been supplied to other countries, irrespective of the local requirements. On the other hand, English capital has built and controlled railways in all parts of the world, and the suggestions of the engineers working these lines have been transmitted home and further elaborated by their consulting engineers, who had current knowledge of the special requirements encountered, which enabled them to arrive at designs suitable to the working conditions of the different lines. The lightness of details in the American engines is against them, and while it is an easy matter in the States to renew these cheaply, this does not hold good when the engines are exported to foreign countries, and to order ready-made details from home is a costly matter which entails the laying out of money that might remain idle for an indefinite period.

"There is, too, a prevalent idea that the roadbed of the South American railways is of a primitive description, consisting mainly of sleepers thrown on to the soil to which the rails are spiked, and that, in consequence, refinement in the fittings and finish of rolling stock is out of place; in other words, the looser things are put together the better they will fit the road. This is a mistake, at any rate in the case of the Central Uruguay Lines, the roadbed of which is of excellent description and ballasted throughout with stone ballast, and the solidity of this construction very soon finds out loose fittings and general weak construction.



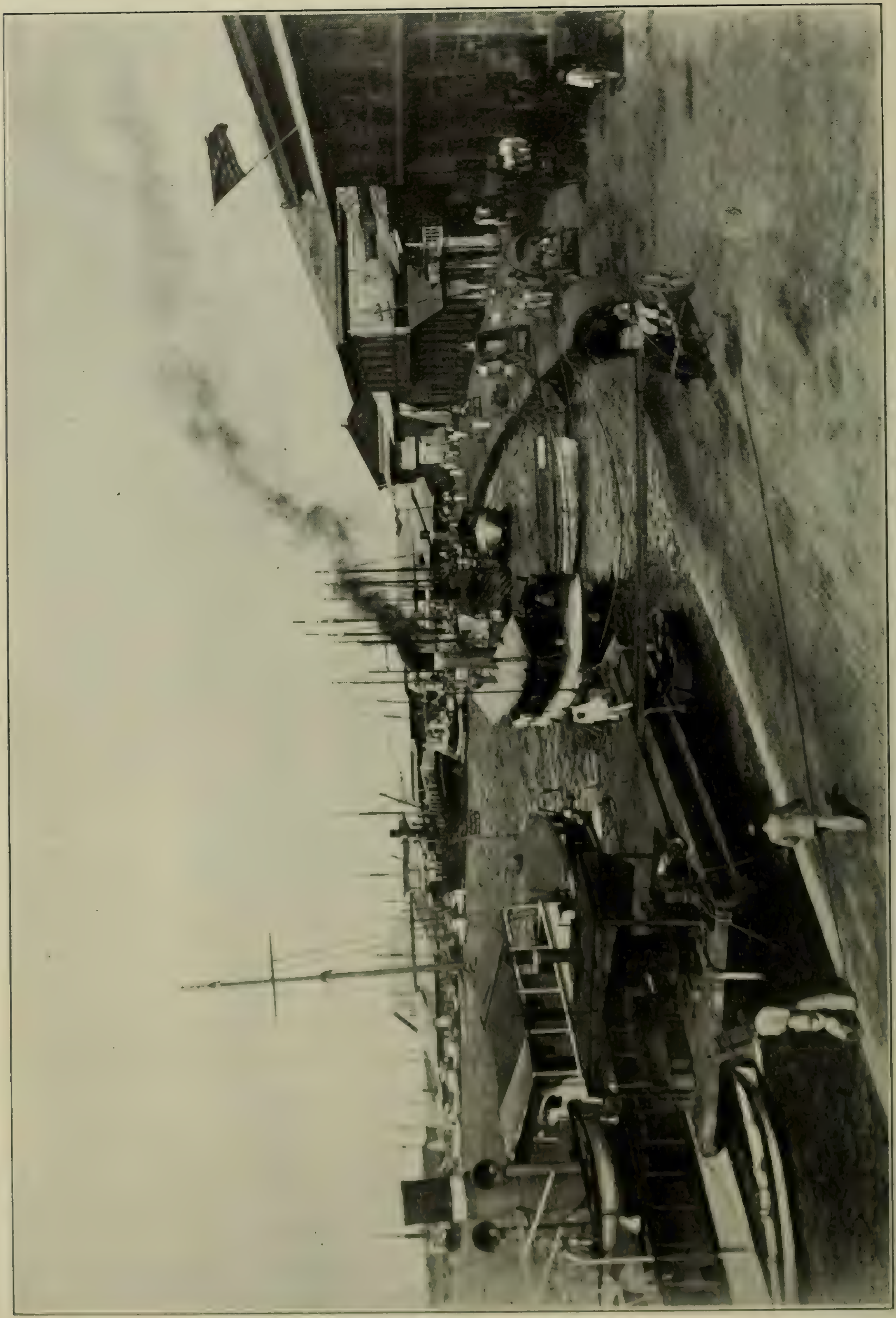
MANANGA RIVER, WHICH WILL FURNISH GRAVEL AND SAND.

THE RAILROAD DEVELOPMENT OF THE PHILIPPINES.

By P. H. Ashmead.

The lack of industrial advantage through occupation by the United States has been stated to be one main cause of discontent in some parts of the Philippines. Mr. Ashmead's article is most interesting in showing how active a feeling of satisfaction has been awakened where manifest industrial advantages have been offered. This aspect of his review is perhaps quite as important as the account of the physical progress of the work.—THE EDITORS.

EIGHTEEN months have elapsed since the Government railway projects in the Philippines took shape through the award to the Philippine Railroad Company of a perpetual concession for building, equipping and operating between three and four hundred miles in the Visayan Islands, and of a contract, similar in size, to the Manila Railway Company on the Island of Luzon. The Philippine Railway Company will complete and equip its lines in four years according to a standard to be agreed upon with the Philippine Government, the Government in turn, by act of Congress, guaranteeing the interest of the thirty-year bonds of the Company at 4 per cent. Thus this concession is stamped at the outset with the mark of United States Government approval and guarantee of support.



THE RIVER FRONT AT ILOILO, THE METROPOLIS OF PANAY.

The undertaking of the Manila Railway Company is essentially a private one, the concessionary syndicate being almost entirely British in personnel and interests concerned. American capital is going into the Philippine Railway Company, and British and other non-American capital into the Manila Railway Company. The Government originally proposed that only Americans should participate in the railway development of the Islands, but the representatives of the Manila Railway Company were already installed on the ground in the old Manila & Dagupan Railway and were so keenly alive to the new railway situation and its possibilities that they succeeded in securing a part of the work, considered by many to present as great opportunity for development as the part held by the former syndicate.

On April 29, 1906, a party of fifty American engineers, organized by J. G. White & Company, the constructing engineers for the Philippine Railway Company, sailed from Seattle to undertake this greatest work of industrial development ever promoted by the United States in the Far East. On June 14 they landed, and the leaders all having been selected for experience in the tropics, no time was lost in beginning surveys.

Upon his first inspection of the ground after his arrival, Mr. E. J. Beard, chief engineer of construction, and formerly principal assistant engineer of the Rock Island, verified most of the preliminary report on resources and location submitted by Mr. L. E. Bennett and published in the form of articles in THE ENGINEERING MAGAZINE for May and June, 1906. With all of the original location tentatively laid down he did not however accord. The first exact surveys on Panay demonstrated a 1 per-cent route between Dao and Passi on Panay, where the Government route called for a maximum grade of 2 per cent. A further change suggested in the Panay railroad was a 15-mile extension west from Jimeno, on the north coast near Batan, to Calivo, tapping a very rich valley having 70,000 inhabitants and producing quantities of hemp, copra, etc., which could advantageously be hauled to Batan or even Iloilo. The original location made a terminus of Batan.

On Negros the original tentative route ran up the west shore from Cabancalan to Victorias, and then bent east along the north shore and terminted at Escalente, 38 miles from Victorias. After looking over the situation, the chief engineer was of the opinion that it would be better to substitute for this section another running southwest through the valley of the Ilog River, which would tap a region rich in timber and more thickly populated than the north.

Notwithstanding the handicap of survey work in a tropical climate through the wet season, the task in hand was unremittingly pursued, the five locating parties vying one with another to achieve the best showing, and in November, 1906, ground was first broken on the Island of Cebu and the actual construction began. Now a second wet season is upon the builders and there is a slight lull in activity which affords opportunity to review the accomplishment of the year.

ENGINEERS' QUARTERS, ISLAND OF CEBU.

On Cebu the surveys have been completed for the 100 miles contemplated, grading is completed upon 35 miles and track has been laid on 27 miles. Operation will shortly be inaugurated on the 20-mile section of the Cebu railroad from the city of Cebu, the busy metropolis of the Southern Philippines, to Danao, the northern terminus. One of the first steps in the construction was to grade and lay the rails on the 7 miles out of Cebu toward the Mananga River, tapping a gravel bed that has supplied ballast for most of the northern half of the line. All the main line from Cebu south to Argao has been located, as has the branch line across the island from Carcar to Barilli. About 4,000 workmen have been employed on Cebu.

On the Island of Panay, where 110 miles of road is being built, the surveys have been completed and construction is well along. The 1,500 workmen now busy on this island show a progress that averages well up with that on Cebu, making due reduction for the somewhat easier country. Four months after undertaking construction the grade was established from Iloilo, the southern terminus, nearly to Pototan, 20 miles north in the interior. Rails are laid 6 miles out of Iloilo and surveys have been made for the additional mileage along the north coast of the island, the construction of which is recommended by the chief engineer, as before noted. With respect to operation, it has now become a question whether the first 20-mile section on Panay or the second section on Cebu will first be ready.

Construction has not yet been begun on Negros, but the surveys of the line originally proposed by the Government along the west coast from Cabancalan through Saravia to Victorias and along the north coast from Victorias to Escalente—108 miles in all—are completed.

A CAMP LOADED ON BULLOCK-CART TRAIN, CEBU.

Just what percentage of the work of the whole system from the commencement of survey to the inauguration of operation throughout has been executed is difficult to estimate exactly, but it may quite safely be figured, counting both survey and construction, that a full one-quarter has been done, even making no allowance for the fact that this first year includes an investment of time in the mustering, training, and organizing of absolutely raw labor that will pay a very high rate of interest for the remaining time.

With the Manila Railway Company on the Island of Luzon construction is progressing satisfactorily, but it may be some little time before any considerable portion is ready for operation. The new roads in Luzon are divided into three principal trunk sections with no less than ten small branches. North, in Benguet Province, there is a 40-mile extension of the Manila & Dagupan road from Dagupan to San Fernando. South from Manila, in Cavite and Batangas Provinces, there is a 70-mile division extending to the town of Batangas on the southwest coast. Again down in the extreme southeast toe of the Island, in Albay Province, there is a 60-mile section between Pasacao and Albay—entirely separated from the extensions of the present main line. The remaining 200 miles is divided among the ten small sections before noted. Judging from latest reports it would seem that about 15 per cent of the new roads on Luzon have been completed.

The problem of the selection of equipment and rolling stock, because of the total lack of experience available regarding the operation of railways in the Visayan Islands and the small fund of knowledge in other countries where analogous conditions obtain, has demanded the exercise of the best judgment of the railroad men and financiers at the head of the undertaking. To insure the selection throughout of the best adapted rolling stock and equipment, there has been formed in New York a technical board, composed jointly of officers of the railway company and the constructing com-

CLEARING THE RIGHT OF WAY THROUGH THE CANE FIELDS.

THREE WEEKS' GROWTH OF NIPA ALONG THE RIGHT OF WAY.

pany and two consulting railway experts, which coöperates with the two chief executives of these companies in the field. The original concession provided for the gauge, which is 3 feet 6 inches, and subsequent questions of construction, equipment and operation have been left to the directors of the Company, the Technical Board, and the Philippine Commission.

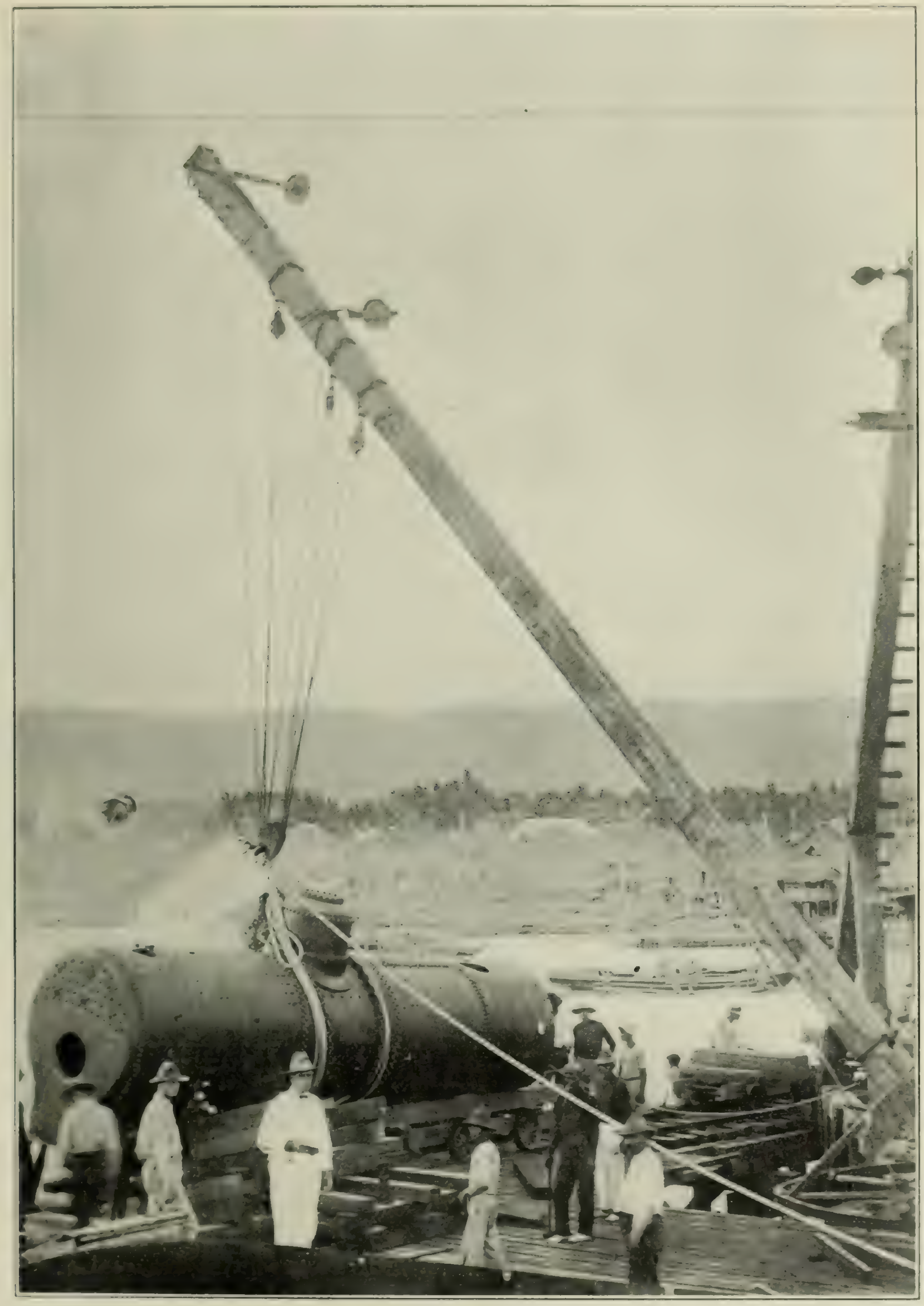
Shortly after the arrival of the first engineering party, early in the summer of 1906, the first consignment of rolling stock and equipment was ordered upon recommendation of the chief engineer of construction. It consisted of four 50-ton Mogul locomotives, to be used first on construction and later for operation, a number of small construction engines, fifty 40-ton flat cars, and fifty changeable ballast cars. Four thousand tons of 70-pound A. S. C. E. steel rails and accessories were ordered at the same time. The Mogul locomotives are exceptionally powerful for narrow-gauge engines, weighing in working order with the tender 92 tons and having a tractive effort of 21,000 pounds. They have 50-inch drivers, straight-top boilers 62 inches in diameter, and 17-inch cylinders with a 24-inch stroke. A high-carbon native lignite coal found on Cebu is the fuel for which the locomotives were designed and they are provided with diamond stacks similar to those successfully used for lignite burning on the Union Pacific.

Spark arresters are provided to prevent setting fire to the *nipa* thatch roofs of the native dwellings. The tenders are of the Vanderbilt type holding 8 tons of fuel and 4,000 gallons of water. For six months now these four engines, with the smaller ones used in grading, have been doing yeoman service, particularly in hauling heavy trains of ballast from the gravel pits at the Mananga River.

A FILL, CEBU.

A second call for rolling stock and material was sent in early this spring, this time including passenger equipment to insure its delivery by the time of beginning operation in Cebu and Panay. Six more Mogul locomotives of the same general design as the first four but somewhat lighter were ordered, together with four combination parlor and first-class cars, four combination mail, baggage, and third-class cars, and fifteen third-class cars. These passenger cars are to be 49-feet long over the buffers. The additional freight equipment in this order was forty 20-ton box cars, forty 10-ton cars, and four cabooses. Four thousand tons more of rails and 4,000 tons of bridges were sent for about the same time.

The design of the passenger cars demanded of the Technical Board more consideration than any other topic and there are still to be settled numerous minor points of finish and fitting. Such factors as the best number of classes to be adopted, the exact requirements of



UNLOADING A LOCOMOTIVE BOILER, CEBU.

the natives in each class and of foreigners traveling in the tropics, the choice of the materials of construction which will best withstand the climate, etc., has to be duly weighed. The trucks are being made

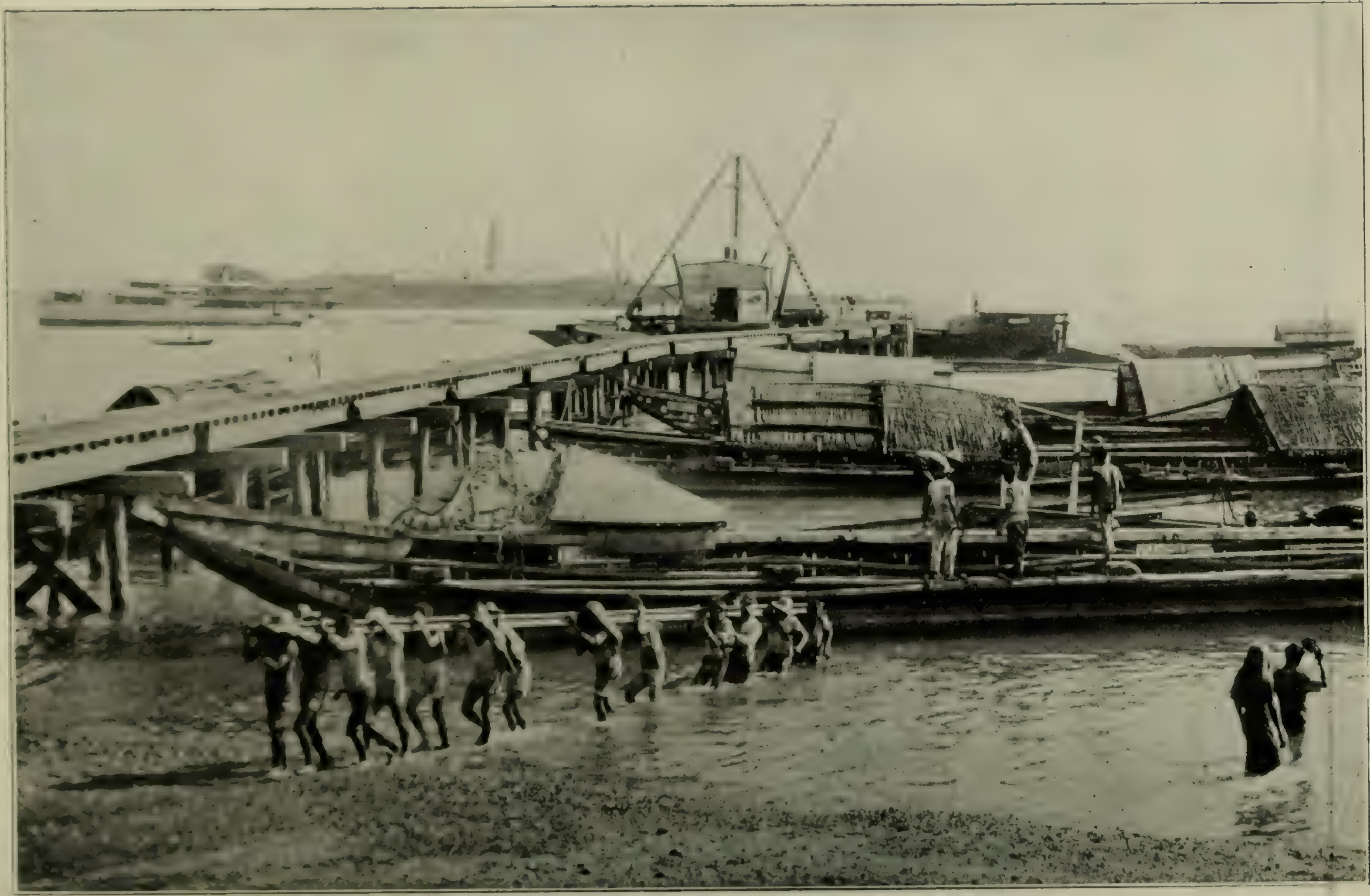
JUST FINISHED SETTING UP, READY FOR STEAM.

to standard designs, the floor frames are to be steel, and the woodwork within and without is to be teak with a natural oil finish. No other wood will resist the ravages of the teredo and white ant, and paint is not sufficiently lasting for the climate. To aid them in selecting the best design of passenger equipment the Technical Board has conducted examinations of current practice on many great railway properties in the tropics, such as the Great Indian Peninsular Railway, the Natal Government Railway, Le Chemin du Fer du Congo, and the Sudan Government Military Railways.

SETTING UP LOCOMOTIVES FOR THE PHILIPPINE RAILWAYS, CEBU.

In the solution of the difficulty of securing rapidly sufficient quantities of ties to keep up with the rest of the construction and equipment, the engineers in the field gave a characteristic exhibition of the resourcefulness and vigor with which the work is being pushed. Australian jarrah ties to the number of 150,000 annually were contracted for, but furthermore, down into the island of Mindanao where it was known that suitable woods grow in abundance there was sent a representative who successfully bargained with His Majesty Datto Piang. The Datto turned some hundreds of his men loose on the job with their native knives and some imported saws, and it is probable that a constant and adequate supply of ties and piles will result.

Naturally no factor in the building of the Philippine Railroads is so interesting as that of labor, for only Visayan natives have been



NATIVE LABORERS UNLOADING RAILS FOR PHILIPPINE RAILWAYS, CEBU, P. I.

used and the experiences encountered must afford a sound basis for judging the mental and physical fitness of the Filipino people to meet the demands of modern industrial progress. Before construction was begun the opinion was quite generally current, among Government officials and business men well versed in the general affairs of the Islands, that the railroads in the Visayas at least could not be built economically or expeditiously save through the importation and general employment of foreign labor, ostensibly Chinese. This belief has never been shared by the executive officials of the construction company. Since the successful adaptation of the natives to the more difficult or rather more technical engineering work connected with the Manila electric street railway and power house, full confidence has been felt in the ultimate proficiency and reliability of Filipino labor.

COMPOUND NO. I, ISLAND OF CEBU.

So, despite opinions, the policy of depending solely on Filipinos resident in the Visayan Islands was adopted, and never has a policy adopted under the shadow of a serious doubt "made good" more effectively. On Cebu, the most thickly populated of all the Philippine Islands, no question has ever been entertained by Mr. Beard or his assistants as to the success of the policy; but they did feel that construction forces for less densely populated Panay might have to be imported from Cebu and other islands, but so far this has proven unnecessary and the progress has been hardly less pronounced on the second island than on the first. It is still felt that Negros, the least densely populated island of the Visayas, upon which construction is still to be begun, will demand an importation of labor from Cebu or Panay, but it is not improbable that here again the native sons will rise to the occasion quite as before.

Cebu presents the fairest opportunity to estimate the capacity of its indigenous workers because the construction has been pushed most rapidly there. Within three months the forces composed of men brought fresh from the plantations where they had never known the use and convenience of modern tools and appliances were able to proceed with the grading using picks, shovels and wheel-barrows, at the rate of 110,000 yards per month, an average of 30,000 yards being rock, drilled by hand. Grades of 4 feet are thrown up without difficulty by the little fellows. And these results were attained despite the fact that the white foremen have left a great deal to be desired, being mostly such representatives of the Republic as could be found in the Islands unattached by contract to any regularly established business or industry.

NATIVE TRACKMEN IN THE MATERIAL YARDS AT LAPUS LAPUS, PANAY DIVISION.

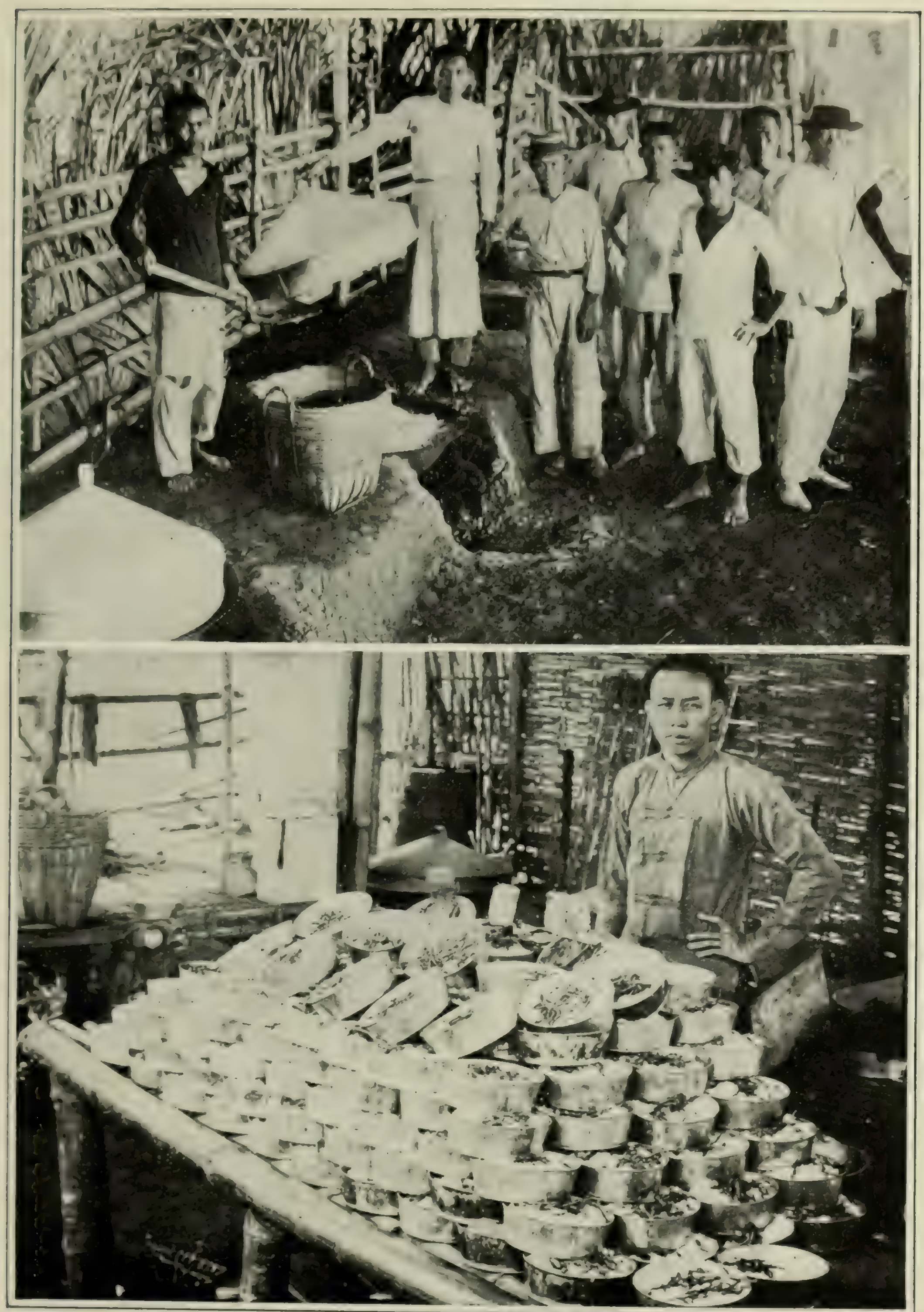
In managing the rank and file of the workmen, but one difficulty worthy of notice has commanded the energies of the executive staff in the field. The workmen all profess religion intensely and they observe with fervor all the holidays in the original Roman Catholic calendar, which subtracts quite a liberal proportion of the total available time of each individual. At the same time the organization as a whole has suffered no demoralization nor has progress been in any material degree impeded. Testimony of this is afforded by the cost of grading, which—taking Cebu for an example because it represents organization in the more advanced stage—is but 12½ cents per yard, being practically, 25 per cent rock work. Steam shovels and the other auxiliaries for heavy grading, as a matter of policy, have been given no place yet in the construction equipment. Heavy transportation expense (which must be reckoned both ways), and cheap labor, have left the pick, the hand shovel, and the wheelbarrow sole possessors of a field in which to prove themselves, and they seem to be doing it, in native hands, never more effectively.

MOVING EARTH FROM A CUT WITH WHEELBARROWS, PANAY DIVISION.

At first a strong predilection appeared for the use of feet and hands rather than picks and shovels for working earth, and it was difficult to persuade some that the wheelbarrows were not receptacles to be carried upon the backs or heads, according to the ancient custom of burden bearing throughout the Orient. With the use of just a reasonable amount of tact and patience such as should be possessed by all white men in colonizing work, and which is nearly always possessed by the colonizing Britisher, for instance, the foregoing little idiosyncrasies of the Filipino were quickly overcome.

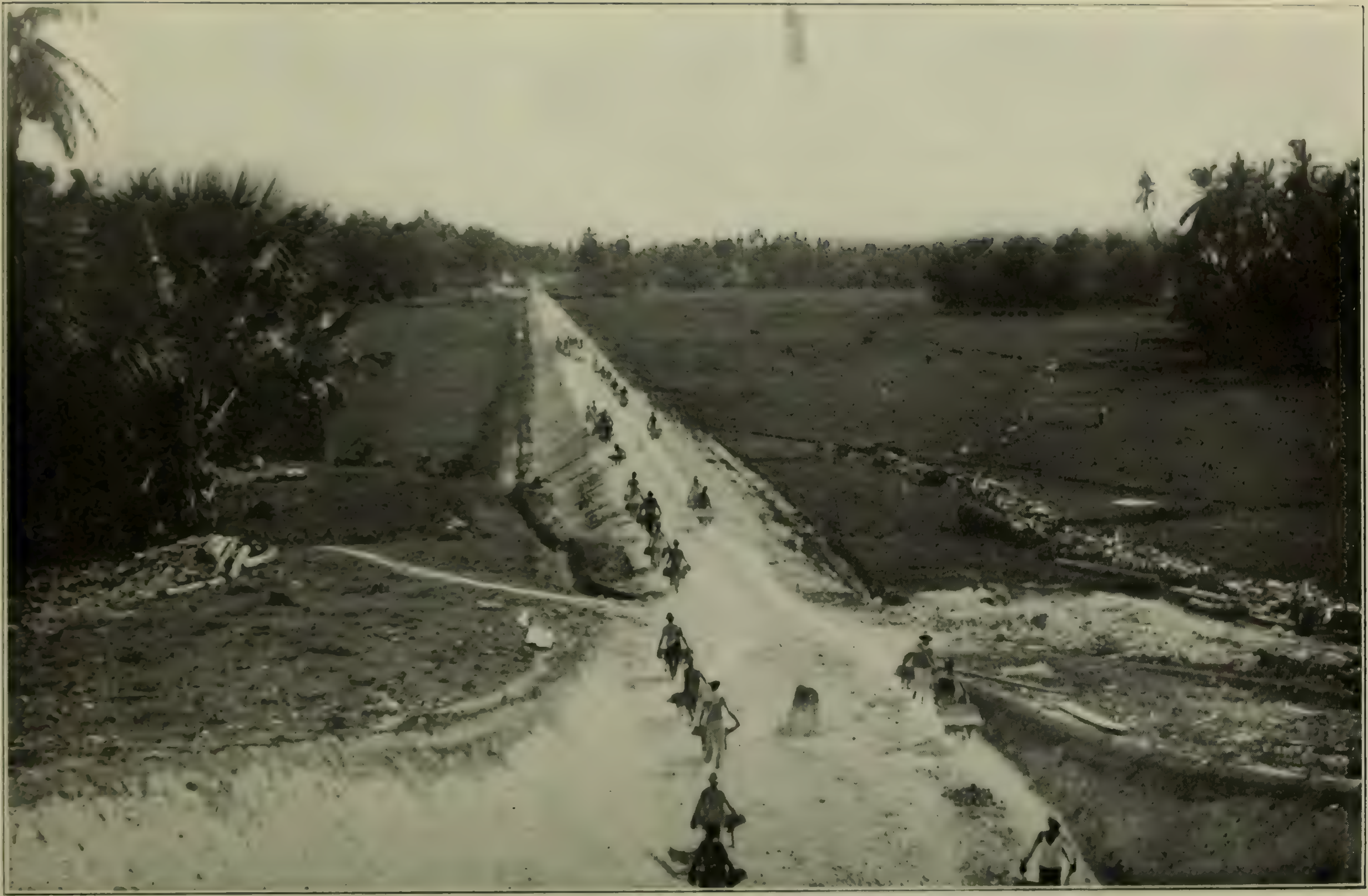
ABOVE, CHECKING MEN AT END OF DAY'S WORK. BELOW, PAY DAY AT HEADQUARTERS. BOTH ON THE ISLAND OF CEBU.

A part of the good result achieved by this American construction company in the use of native labor on engineering work, which contrasts with the lack of success met with formerly by Spanish com-



COOK HOUSE OF AH GONG, THE COMMISSARY AT ILOILO. FOOD READY FOR DISTRIBUTION TO NATIVE WORKERS.

panies, may safely be ascribed to one radical change in the mode of management. Formerly it was the custom to hire labor by contract. The contractor or *haciendero* habitually reduced the wages to as low a



A CUT AND A FILL, WITH NATIVE LABORERS AT WORK.

FINISHED GRADE JUST NORTH OF JARO, PANAY DIVISION.

scale as was possible and still keep the men somewhere near the job. Worse than this, they not infrequently withheld wages altogether. Under the new *régime* the *haciendero* is eliminated and the real employer deals directly and pays wages directly. As soon as the men realized that steady work meant steady pay and a regular dependable cash income, they took hold hard.

The chief engineer has little but praise for the qualities of the natives as railroad builders. Already, he says, many have attained an efficiency almost, if not quite, equal to that of white laborers, working, not in the Philippines or other tropical lands, but at home in the United States. This substantiates what was learned in the construction of the Manila Street Railway—that when properly handled, the natives can be safely relied upon to acquit themselves creditably of their part in laying a stable foundation for their own industrial and commercial welfare. While it cannot reasonably be claimed that they are fit to govern themselves now, the natives when given a perfectly fair show have not failed to demonstrate their capacity for work, and their aptitude, and it is really left only for the Government to encourage and support such industries as will give them their full opportunity. The sole essentials for a pronounced material welfare, aside from governmental stability, are sufficient natural resources and this industrious spirit, so there is no basic reason why the Philippines cannot be made a source of substantial national revenue to the United

THE CEBU TERMINAL, EARLY IN 1907.

States. The construction of the Philippine Railways under Government patronage seems to be a long step in the right direction. A supplementary and not less essential one will be the provision of a market in the United States for Philippine products.

All of the hundreds of thousands of dollars distributed as wages will be spent and circulated in the Islands. An industrial army of from 20,000 to 30,000 men will have been formed, and such of these as are not required in the operation of the railroads will be available for other industries which will surely be given a strong impetus by the supply of good and cheap transportation. All who have been engaged on the railroads will have for themselves an unprecedented and invaluable training in the habit of regular work. Some will go to the mechanical trades and industries where their special training will stand them in good stead, and some will go back to the plantations where their increased efficiency will find full scope in helping to develop the output scientifically so they may meet the increased demand for their products that will come with cheap and effective transportation. All these economic effects redounding to the future prosperity of the railroads are attained practically without sacrifice in the present construction work. Allowing the possible maximum difference in wages between the two classes of labor, labor as a whole is so cheap that the total cost of the roads could not have been varied more than 5 per cent by the use of Chinese.

THE COMPARATIVE COST OF STEAM AND HYDRO-ELECTRIC POWER.

By William O. Webber.

The extent to which Mr. von Schon's recently concluded discussion has been quoted or reviewed, shows that in his comparison of steam and hydro-electric power an important subject was ably handled. We are glad in the subjoined pages to follow the topic further under the guidance of another specialist whose cost data are drawn from actual experience with working installations. It is a mistake to assume, as one or two of our correspondents have done, that there is a shadow of unfriendliness to the steam-power plant, or of over-partiality to the water-power, in the mind of either of our contributors or of the Magazine. The engine can never be dispossessed by the water wheel, under the utmost conceivable extension of the development of stream powers. But in the interest of economy of natural resources it must be supplemented as far and as fast as possible, and Mr. Webber unites with Mr. von Schon in displaying the comparative economy at which this new and additional power resource may be secured, using the more familiar type of installation as a standard.—THE EDITORS.

THE articles by Mr. H. von Schon which appeared in THE ENGINEERING MAGAZINE, April-June, 1907, appear to me after careful reading to be the best written on the subject for some time. In the main they command full agreement, especially as to the concluding installments. In the cost comparisons given in the initial section of the argument, however, there is opportunity for discussion and I submit the following data by way of commentary and supplement.

As usual in similar cases, no account has been taken of the land upon which all power plants must be situated (unless on board ship or attached to flying machines), and while the cost of buildings is generally placed too low, nothing at all is allowed for the construction of proper chimneys.

Take, for instance, the 10 horse-power plant, where the cost of buildings is given as $400. This would just about build the chimney for such a plant, and the boiler and engine room would cost at least as much more; while, in the items for boiler and engine, no account seems to have been taken of the auxiliaries, which, in most urban districts at least, are compulsory in connection therewith.

If, for the sake of argument, it is assumed that so small a plant as one of 10 horse power would be a semi-portable plant, with a simple sheet-iron chimney, then the extra fuel costs would much more than make up for the fixed charges of a return-tubular boiler, with proper brick setting and brick chimney.

I have found that, with coal at $4 a ton, the cost of steam power per brake horse power is almost exactly double the cost of the fuel alone. The accompanying table, based on actual experience, shows that, with fuel at $2.50, the rates per horse-power hour are as follows:

4.65 cents for 10 horse power
3.42 " " 20 " "
3.76 " " 40 " "
2.41 " " 60 " "
2.20 " " 80 " "

With coal at $4.50 a ton, these rates would be

6.+ cents for 10 horse power
4.50 " " 20 " "
3.66 " " 40 " "
3.20 " " 60 " "
2.92 " " 80 " "

I append on the opposite page two tables of actual installations, showing what costs actually are, also just below on this page, a table of the value of small powers, from 10 to 80 horse power, and on page 892 is a diagram which, I believe, more nearly represents actual practice today; I have prepared also, and give on page 893, a memorandum of working plants which have come under my own personal knowledge, with the actual results as obtained.

COST OF ONE STEAM HORSE POWER, PER BRAKE HORSE POWER PER YEAR.

Size of Plant.	10	20	40	60	80
Cost of Plant per Horse Power..	$230.00	$200.00	$190.00	$180.00	$175.00
Fixed Charges at 14 Per Cent....	32.20	28.00	26.60	25.20	24.50
Coal per Horse Power per Hour..	15.00	12.00	10.00	9.00	8.00
Cost of Coal @ $4.00 per Ton....	82.50	66.00	55.00	49.50	44.00
Attendance 3,080 Hours..........	50.00	30.00	20.00	15.00	13.00
Oil, Waste and Supplies per Year.	10.00	6.00	4.00	3.00	2.60
Total	174.70	130.00	105.60	92.70	84.10
Without Coal	92.20	64.00	50.60	43.20	40.10
Coal @ $5.00 per Ton............	195.00	146.50	119.35	105.07	95.10
" " 4.50 " "	185.01	138.25	112.47	98.80	89.60
" " 4.00 " "	174.70	130.00	105.60	92.70	84.10
" " 3.50 " "	164.38	121.75	98.72	86.51	78.60
" " 3.00 " "	154.00	113.50	91.85	80.32	73.10
" " 2.50 " "	143.74	105.25	84.97	74.13	67.60
" " 2.00 " "	133.42	97.00	78.10	67.95	62.10

There is no question as to the cheapness of hydraulic power; I have many figures, ranging all the way from $3.38 to $6.00 per horse power per annum. The actual costs on hydro-electric power vary, of course, with the distance the current is transmitted; but they may be taken, approximately, as $10.16, in the immediate vicinity of the water-fall, $11.66, with a four-mile transmission, and $12.81 for a 20-mile transmission.

TOTAL COST OF INSTALLATION, 10 HORSE-POWER STEAM PLANT.

Land for Engine and Boiler Room, 300 sq. ft. @ $1	$300.00	
Boiler and Engine-Room Building, 300 sq. ft. @ $1.50	450.00	
Chimney, 18 in. by 40 ft	400.00	$1,150.00
10 H.P. Boiler	$241.00	
Boiler Foundation and Setting, 3,900 C. B., 500 F. B.	160.00	
Blow-Off Tank	31.00	
Damper and Regulator	75.00	
Injector Tank	10.00	
Water Meter	40.00	
Piping for Same	20.00	
Pump and Vacuum	122.00	
Feed-Water Heater	40.00	
Pipe Covering	50.00	789.00
Engine, 7 by 10	$184.00	
Foundation for Same	60.00	
Steam Separator	35.00	
Oil Separator	25.00	
Piping	95.00	
Freight and Cartage	30.00	429.00
		$2,368.00

Hydro-pneumatic power would be the only serious competitor for hydro-electric power within a 20-mile radius of a power plant; beyond that distance the electricity would always win. For very small plants, undoubtedly gasoline and the small producer-gas plant

TOTAL COST OF INSTALLATION, 60 HORSE-POWER STEAM PLANT.

Land for Engine and Boiler Room		$2,500.00
Buildings for Engine and Boiler Room		2,500.00
Chimney		1,200.00
80 H.P. Boiler	$790.00	
Ash Pan for Boiler (Below High-Tide Level)	120.00	
Boiler and Engine Settings	1,282.00	
Blow-Off Tank	31.00	
Damper Regulator	75.00	
Injector Tank	10.00	
Water Meter	60.00	
Piping for Same	22.13	
Pump and Receiver	146.50	
Feed-Water Heater	70.40	
Pipe Covering	70.75	2,677.78
Engine, 12 x 30	$1,065.00	
Pan for Engine Fly Wheel	72.00	
Steam Separator	60.00	
Oil Separator	41.80	
Piping, Freight and Cartage	1,026.41	2,265.21
Shafting in Place	$550.00	
Belting in Place	285.00	835.00
	$199.55	$11,977.99

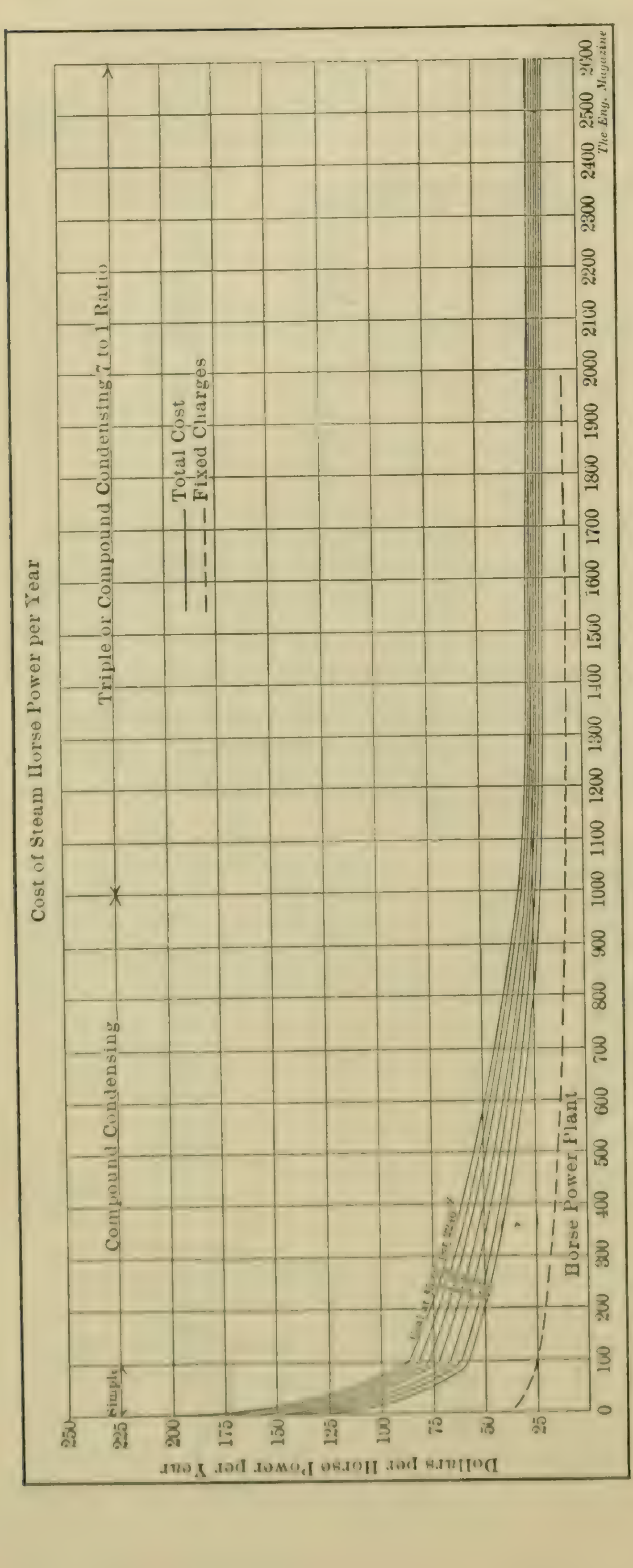


CHART SHOWING COST OF STEAM PER HORSE POWER PER YEAR UNDER VARIOUS CONDITIONS.

would successfully compete with electricity, as it would not pay to develop water powers so small.

Too much cannot be said in regard to proper development of hydro-electric plants. Even a period of 10 or 15 years is too short in which to study the monthly and annual precipitation on a given drainage area, as records show that marked variations, covering periods of 30 and 40 years, occur in the rainfall. The table on the opposite page shows the average of the flow of New England streams, and the figures will be seen to corroborate the dictum that one cubic foot per second per square mile is the maximum safe development of a New England stream.

TABLE OF AVERAGE FLOW OF NEW ENGLAND STREAMS.

Months by Per Cent. of Collection.	Month and Number of Days.		Average Rainfall, 1818-1897.	Average Per Cent. of Collection.	Depth in Inches of Collection.	Equivalent Run-Off in Cu. Ft. Sec. per Sq. Mile.	
1	Aug.	31	4.35	21.3	.9265	.835	
2	July	31	3.68	21.8	.8022	.695	
3	Sept.	30	3.52	28.3	.996	.895	.808 average flow for three dryest months.
4	Oct.	31	3.90	29.3	1.143	.99	
5	Nov.	30	4.30	36.5	1.569	1.41	.965 average flow for five dryest months.
6	June	30	3.22	44.8	1.442	1.29	1.019 average flow for six dryest months.
7	Dec.	31	3.89	60.7	2.371	2.06	
8	May	31	3.80	65.8	2.50	2.17	
9	Jan.	31	3.95	76.3	3.014	2.61	
10	March	31	4.30	78.8	3.388	2.94	
11	Feb.	28	3.80	132.2	5.024	4.82	
12	April	30	3.98	145.0	5.77	5.18	2.16 average flow per year.

I do not agree with Mr. von Schon that hydro-electric developments should be "based on some stage between the low and normal flow," as it has always been found profitable to carry on the development to some stage between the normal and high flow of a water shed. This can be determined only upon local costs of auxiliary power, but usually can be taken up to the average flow of the ninth month, in the order of dryness.

TABLE OF ACTUAL COSTS OF WORKING STEAM PLANTS.

Ave. H.P.	Cost of Coal per Ton 2,240 Lb.	Total Cost per Annum.	Remarks.
182	$3.50	$57.59	No land or building cost.
133	3.25	60.00	" " cost.
100	3.50	65.60	" " or building cost.
97	4.45	86.80	All costs included.
75	2.90	92.40	No land or building cost.
50	4.75	111.05	" " " " "
20	4.45	133.50	All costs included.

A GRAPHICAL WALL RECORD FOR THE PRODUCTION DEPARTMENT.

By H. L. Whittemore.

The graphical record and the card index are well-known aids to effective works management. Mr. Carpenter, in his widely noticed current series in this Magazine, has pointed out the stimulating influence exerted by publicity in the records of work expected and work performed in various departments. The system explained below by Mr. Whittemore is an ingenious and admirable combination of all these elements into a plan interesting in its originality, and offering many possibilities of advantage in its introduction into the factory.—THE EDITORS.

ANY "recording system" may be considered a machine for memorizing facts which preserves the original entry, unaltered, for any length of time. The human memory, on the other hand, not only has a very limited capacity, but the record is gradually obliterated until finally it ceases to exist. Apparently these machines are as successful, in replacing the unaided human faculties, as the other machines which are considered so important in modern production methods. Certainly they have come into very general use, especially for commercial purposes. Even when the magnitude of the task does not make them a necessity, they often reduce the cost of the work, as they may be operated by persons unable to perform the duties without their aid.

Other advantages are that they may be used by any number of persons, either for the purpose of recording or for obtaining information, and they continue to serve the interests of the organization creating them, independent of changes in personnel.

Without some means of crystallizing the ideas or facts into tangible form, no record would be possible. There are many ways of accomplishing this, among which may be mentioned the phonograph and the telegraphone, but visual records are the kind most generally used. In some cases, it is possible to record ideas by photographs or drawings of the objects as they appear to the eye, but not all ideas can be so expressed. Written language (which is said to be a highly developed outgrowth of the pictorial records of our primitive ancestors) has, however, universal application. While the majority of our records will continue to be made in written English with the necessary labor reduced to a minimum by the use of abbreviations, printed forms and columns properly headed, some special cases allow other means to be employed to advantage. Of these, shorthand is a good example.

Diagrams, where they are suitable, possess the advantages that they are easily read and quickly constructed. Possibly they could be more often used for record purposes, if their advantages were duly considered. The diagram employed for this production record, upon trial, proved to have the unexpected advantage that the facts were presented much more quickly and clearly than by the customary written record. It was devised for one of the departments, known as Division C, of a manufacturing plant employing several thousand men. From it is gained quickly, accurate information regarding the progress of the work upon any order received by the division.

All drawings and specifications, for the use of the shop, are prepared by the engineering offices, of which Division C is one, from the orders received from the sales department. Changes made necessary after an order is issued are made upon a "change notice" form similar to the printed form used for the orders, and distributed in the same manner to the engineering offices. While information relating to any order may be given verbally by one department to another, it is unofficial unless contained in a letter to the department for whom it is intended.

The route followed by an order, in Division C, is shown in Figure 1, divided into three distinct parts—the work of the engineers in determining upon the design, that of the draftsmen in preparing the drawings (if new ones are necessary) and compiling a list of the ones to be used (in either case), and finally, the preparation of the specifications by the specification clerks.

The production record follows a parallel route at the desk of the production clerk. He devotes most of his time to this work and only under exceptional circumstances allows a record to leave his possession. For the record, the card form shown in Figure 2 is used. This is filled out from the order when the latter is first received from the sales department, then filed, conspicuously, in the wall rack (L-O, Figure 1) until the work of Division C is complete. Upon the completion of any part of the work, the order is returned to the production desk to allow the record to be posted, when the position of the record in the wall rack is also changed.

The most unusual feature of the record card is the calendar along the top edge upon both sides. The part containing the current month is always visible when the card is filed in the wall rack (see

Figure 6) and the diagram upon it supplies all the information usually required. By arranging the calendar, thus, in four lines, the scale is made large enough to allow the dates upon the diagram to be accurately read. The lines which should represent Sundays are omitted as it is found that by so doing, the diagrams are more quickly drawn and also that time intervals, in weeks, are quickly estimated. Of course, this makes a new calendar necessary for each year. Orders which extend from one year into the next are continued upon a new card and all such cards are fastened together by paper clips. If desired, the diagram may be continued upon the first part of the calendar on the same card, even though it is incorrect, provided the diagram does not overlap. This avoids the use of more than one card for an order except in rare instances. Probably some form of perpetual calendar could be devised for this pur-

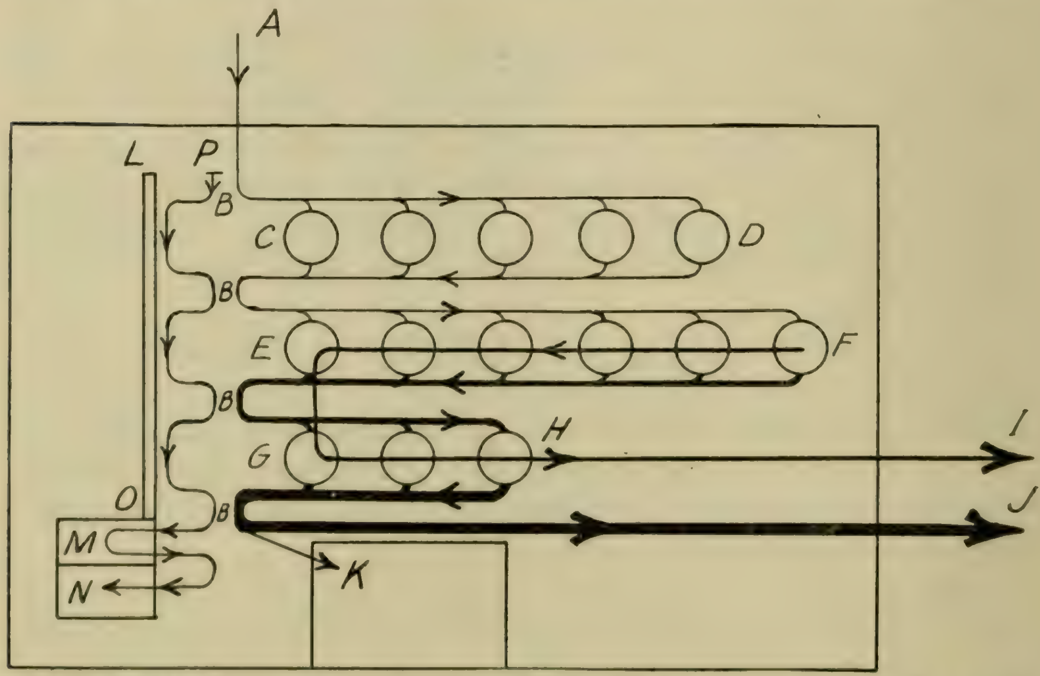
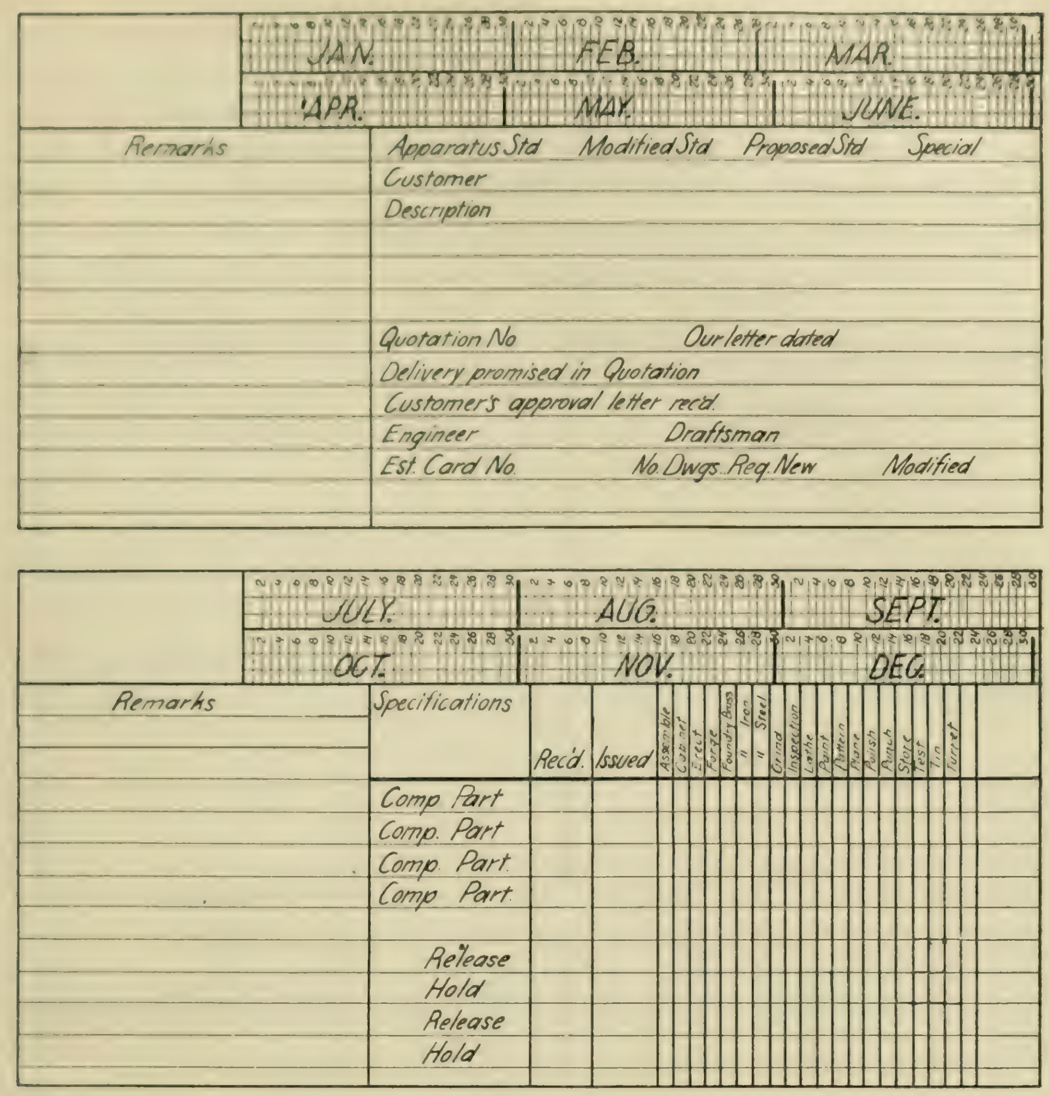


FIG. I. DIAGRAM SHOWING THE ROUTE A-J, OF ORDERS; PARALLELED BY THE ROUTE P-N, OF THE PRODUCTION RECORD.

The orders are received at the production desk, B, from the sales department, A; distributed to the engineers, C-D, who return them to the production desk, B. They are redistributed to the draftsmen, E-F, who return them with a list of the drawings required. The drawings pass directly to the specification clerks, G-H, then to the shop blue-print stores by way of the blue-print department, I. The orders are received by the specification clerks, G-H, from B, and returned with the complete specifications. Copies of the order, drawing list, etc., are filed in the vault, K, for office reference and the specifications delivered to the shop, J. The production-record card is filled out at P, when the order is first recieved at the production desk, B. It is then filed in the wall rack, L-O, constantly changing its position as the work upon the order progresses. When the completed specifications are sent to the shop, the record is filed in the "shop file," M, until notice is received of the final shipment of the apparatus to the customer, when the record is transferred to the "completed file," N.



JAN. FEB. MAR.
APR. MAY. JUNE.

Remarks

Apparatus Std Modified Std Proposed Std Special
Customer
Description
Quotation No Our letter dated
Delivery promised in Quotation
Customer's approval letter rec'd.
Engineer Draftsman
Est. Card No. No. Dwgs. Req. New Modified

JULY. AUG. SEPT.
OCT. NOV. DEC.

Remarks

Specifications
Rec'd.
Issued
Assemble
Cabinet
Erect
Forge
Foundry Brass
" Iron
" Steel
Grind
Inspection
Lathe
Paint
Pattern
Plane
Polish
Punch
Store
Test
Tin
Turret

Comp. Part
Comp. Part
Comp. Part
Comp. Part
Release
Hold
Release
Hold

FIG. 2. THE FORM USED FOR THE RECORD CARD, 4 BY 8 INCHES.

A complete history of every order is recorded upon this card, most of it graphically upon the calendar at the top which is always visible when the card is in the wall rack. Besides requiring somewhat less time to make, the graphical record has the great advantage that from it a grasp of the situation can be gained which would be almost impossible from a written record.

pose which would be satisfactory, even though it did not possess all the advantages of Figure 2.

The time required for the engineers and draftsmen to complete their work is recorded by the length of the diagram drawn by the production clerk upon the first of the horizontal lines through the calendar. While the engineer supervises the work upon the drawings, it is comparatively seldom that he causes serious delay upon them when once started. Moreover, as no definite division can be made between the work of the engineer and that of the draftsman, a large dot is used to record the date at which the drawings are started, so that an estimate may be made of the time required by each of them. The middle horizontal line is used for the record of the specification clerks and the heavy bottom line for that of the shop, although the work of Division C is complete when the diagram reaches the shop line.

The appearance of this record at various stages of completion is

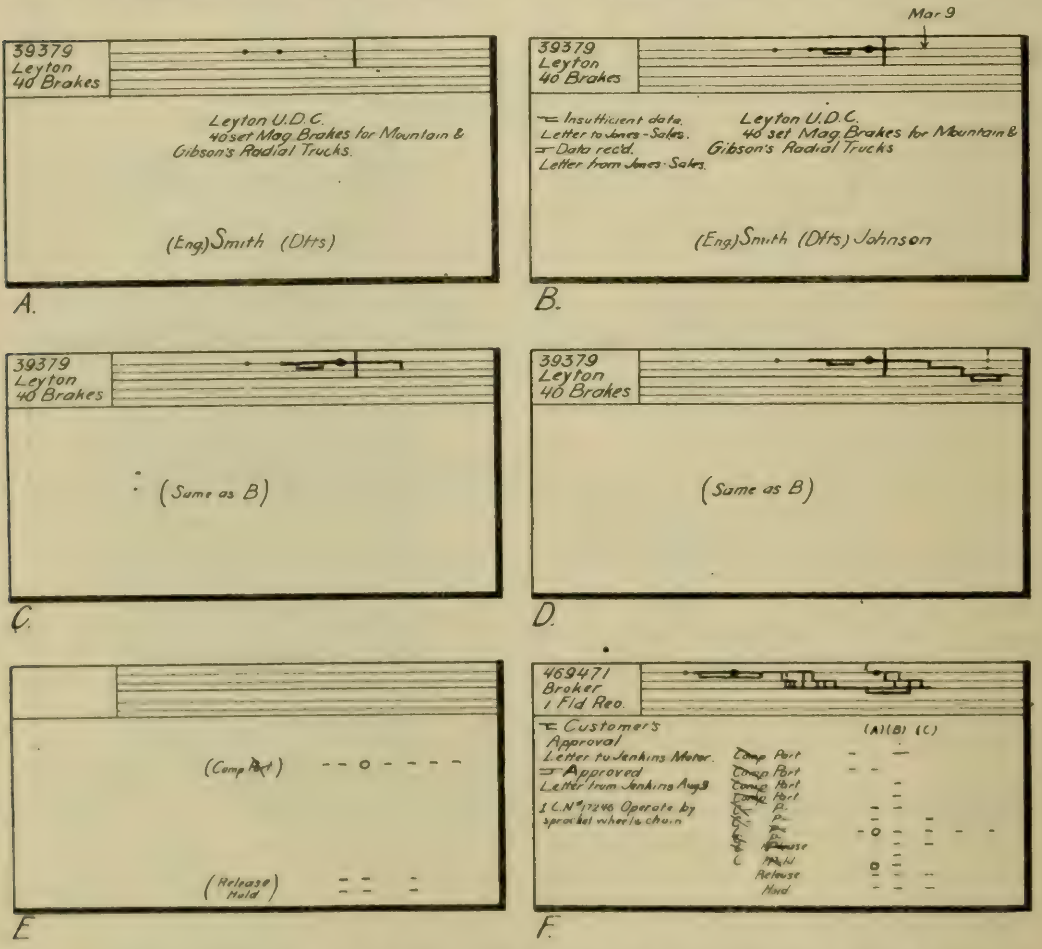


FIG. 3. PROGRESSIVE STAGES IN THE COMPLETION OF A PRODUCTION RECORD, SHOWING GRAPHICALLY THE PROGRESS OF THE WORK UPON THE ORDER.

A. Card as filled out upon receipt of the order; first dot—date order was issued; second dot—date order was received in Division C; vertical line—shipping date specified.

B. Large dot—date drawings were started; double line—"hold" upon the order.

C. Drop in diagram to second line—date specification clerk received the order and the list of drawings.

D. Drop in diagram to the bottom line—date specifications were delivered to the shop; double line—"hold" upon work in the shop; dotted vertical line—date of shipment promised by the shop.

E. Reverse of D. Dashes—the departments in the shop to which specifications were delivered, or notices to "hold" or to "release hold" upon the order. Complete, not partial, specifications sent in this case. Circles—departments assembling the completed apparatus.

F. Example of record such as occurs frequently in practice. Second part of diagram (1)—"change notice" altering the method of operating the apparatus.

shown in outline in Figure 3, only the written portion of the card being shown and the printed calendar being omitted so that the record lines may stand out more clearly on the small-scale reproduction. At the left of the calendar is placed a very concise copy of the order for which every suitable abbreviation is used. Beneath the calendar, this is repeated more fully but still in condensed form due to lack of space and the cost of making a full copy.

A shows the appearance of the record at the time the order is delivered to the engineer; B, upon March 9, after the drawings have been started as indicated by the heavy dot. As the production clerk extends the diagram after having made personal inquiries of the person having the order in his possession, the interval between the end of the diagram and March 9, shows that he has not "looked up" the order during that time. Usually such intervals should not exceed six days, at most. While the production clerk is not given authority to dictate to any member of the staff regarding an order, but only to gather and record the facts, his inquiries and suggestions tactfully made are a material aid in completing work rapidly.

A "hold," indicated by the double line, records the length of time work upon the order was delayed due to circumstances over which Division C had no control—in other words, a delay for which Division C is not responsible. The reason for the "hold" is stated under "remarks," in this case (B) the lack of necessary data to proceed with the design. The engineer, upon discovering this fact, stated the circumstances, including the fact that the order was held, in a letter to Mr. Jones of the sales department. Such letters being brought to the attention of the production clerk, he recorded the "hold" beginning upon the day the letter was written. Upon a request that the work upon an order be discontinued, coming from another department who assume the responsibility for the delay, a "hold" is recorded in the same manner, but in any case correspondence must be available for any "hold," clearly showing the inability of Division C to proceed with the work. The "holds" are released in much the same way by correspondence. In the case shown in B, the hold is released by a letter from Mr. Jones supplying the data.

Shop "holds," as illustrated in D, differ from those in Division C, in that they may be placed upon an order either by persons within or without that division. They are recorded upon the diagram in the same manner and a record made, as shown at E, of the departments notified of both the "hold" and of its "release."

The record is completed by the production clerk when he is advised of the date on which final shipment upon an order is made to the customer. He then draws a short vertical line across the shop line, and usually a diagonal line across the card from corner to corner upon both sides to prevent its ever being confused with current records. From the time the diagram reaches the shop line until shipment is made no attempt is made to post the diagram unless a "hold" is placed upon the shop or a promised shipping date is obtained from them. Usually the shop portion of the diagram is drawn entirely at the time the record is completed. The information to be obtained from this production record, as illustrated in Figure 3, is, then, somewhat as follows,

A, the order was issued February 2, and received in Division C, February 10, about one week later. Shipment is to be made February 28. Mr. Smith is the engineer having the order in charge.

B, (March 9) the engineer was unable to proceed with the work so the order was "held" in accordance with this letter to Mr. Jones of the sales department written upon February 13. Mr. Jones' reply, supplying the data, was received upon February 20, the day it was written, and the "hold" was removed. This caused a delay of one week. Drawings were started by Johnson, February 24. The shipping date has been passed and the order was last "looked up," by the production clerk, upon March 3.

C, the drawings were completed upon March 10.

D, complete specifications were delivered to the shop upon March 17, Saturday, and they promise shipment upon March 24. Work was, however, "held" in three departments of the shop, from March 19 to March 27. Division C is then responsible for 28 of the 43 days between the time the order was issued and the time specifications reached the shop.

E, the record of the departments to which specifications were sent is a check upon complaints from the shop, that no specifications were received or that "release" notices were not sent to all departments receiving "hold" notices.

While only a simple case is illustrated by the cards, A to E, much more complex ones are similarly made, as shown by F, which is by no means an example of extreme complication. From this it will be seen that specifications were sent to the shop upon seven different days and all except the last were partial specifications only. Later the method of operating the mechanism was altered by a "change notice." Work was immediately "held" in the shop in departments, A, B, and C, until the necessary changes in the specifications could be made. "Rush orders" frequently make it necessary to send specifications to the shop as rapidly as they are completed, so that frequently complicated records result.

It is desirable to print the calendar portion of the card in red or other light color so that the diagram, drawn in pencil for convenience, will show well by contrast. While it was intended that all the blanks shown in Figure 2, should be filled out by the production clerk in the course of his work, it is very seldom, in the everyday rush, that more appears upon the cards than is shown in Figure 3. The reason for this is that the information which we must have to complete the card can only be obtained from the engineer after the latter has given the order some consideration, which it is not always convenient for him to do immediately. While it might be obtained by properly planning the whole order system, use seems to show that it would hardly be worth the increased cost, and that the best results are obtained by requiring of the production clerk only such work as requires no technical knowledge. As he is the only person recording information upon the cards, he alone is responsible for its accuracy, as well as for the constant use of the information at his command in assisting the remainder of the staff to complete the orders rapidly and accurately. He is in a position to prevent many costly errors,

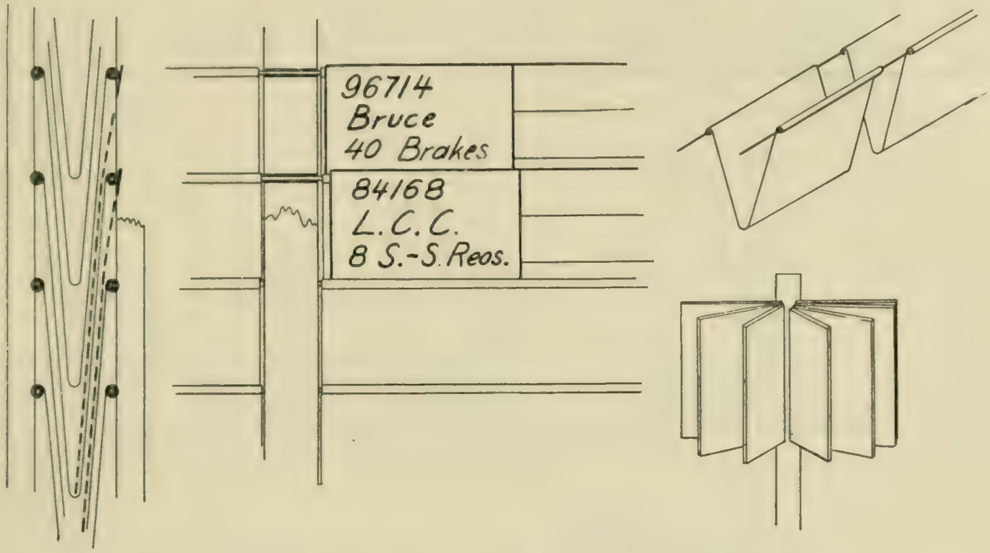


FIG. 4. SWINGING WALL RACKS FOR CURRENT ORDERS.

Both sides of the swinging panels are used for filing record cards, their size and number depending upon the number of cards. The cards are held in pockets formed of sheet metal and suspended upon wires. As they are without joints it is impossible for the cards to slip down inside the rack. The frames may be of wood or metal. This arrangement, while much more compact than that shown in Fig. 5, secures but little more publicity for the records than an ordinary card file.

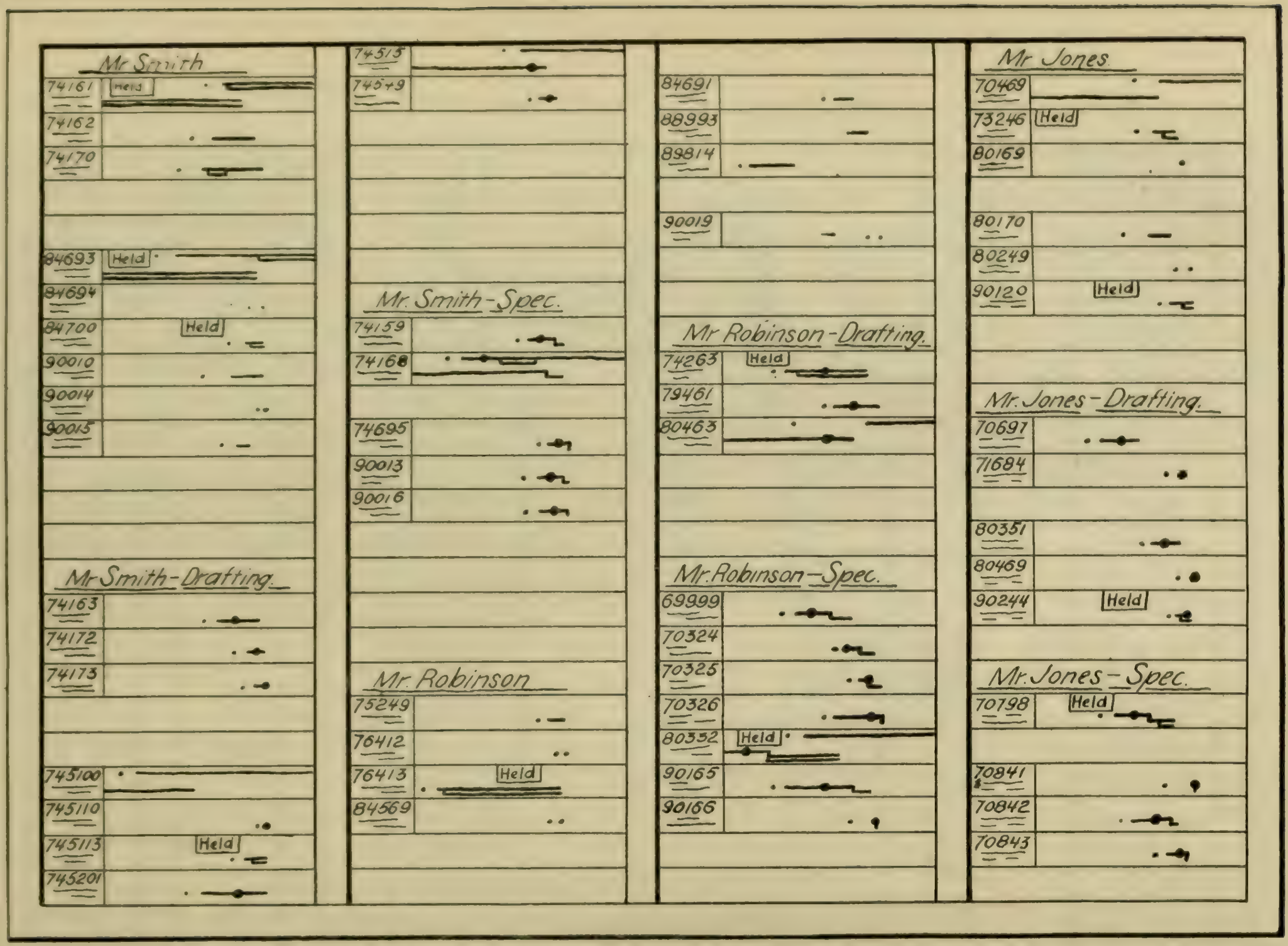


FIG. 6. STATIONARY WALL RACK (L, O, FIG. I), SHOWING ARRANGEMENT OF RECORD CARDS FOR CURRENT ORDERS. The orders for which each engineer is responsible are grouped together for convenience. This allows him to follow their progress without making personal inquiries. Any other arrangement could be used. They are subdivided into those in his possession personally and those upon which the draftsmen and specification clerks are at work. Of the cards illustrated in Fig. 3, A should be filed under "Mr. Smith"; B, under "Mr. Smith—Drafting"; and C, under "Mr. Smith—Spec." The division headings, (Mr. Smith—Drafting) are lettered upon cards which can be easily shifted as circumstances require. The record cards are filed numerically in any one division. By glancing down the columns the orders which have been making unsatisfactory progress may be rapidly selected.

such as the delivery to the shop of specifications upon an order which is "held."

The wall racks which may be used are detailed in Figures 4 and 5. The latter is the form used in Division C, and it presents the appearance shown in Figure 6. Empty pockets, at frequent intervals, permit new cards to be inserted quickly in their proper numerical order.

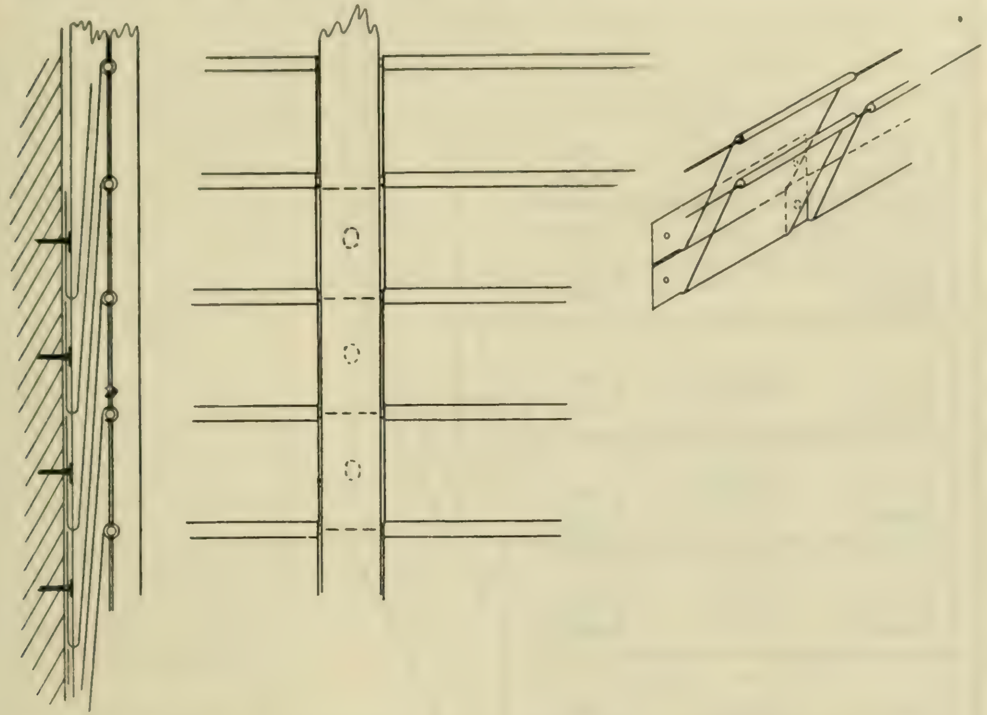


FIG. 5. DETAIL OF STATIONARY WALL RACK FOR CURRENT ORDERS, FIG. 6.

Sheet-metal pockets for the cards. The rack used in Division C measures about 6 ft. by 8 ft. and contains between 600 and 700 pockets. To prevent loss of time in shifting cards, about twice the number of pockets absolutely necessary should be provided.

Each record card is filed first under the name of the engineer, say Mr. Smith, then under his drafting and specification sections, although the men doing the last two parts of the work are not confined to his work at all but take orders coming from any of the engineers. The position of the card, then, in the rack, always corresponds with the member of the staff having possession of the order. Those upon which "holds" are placed are tagged with removable clips such as are used for indexing ledgers and other work. They are removed with the "hold" as seen in Figure 6. When removed from the wall rack, upon the completion of the specifications, the card is removed to a card file as shown at the top of the case in Figure 7. It is filed there numerically and tagged "held" if such is the case. Upon completion of the order in the shop the card is transferred from this "shop" to the "completed" file contained in the drawers shown in

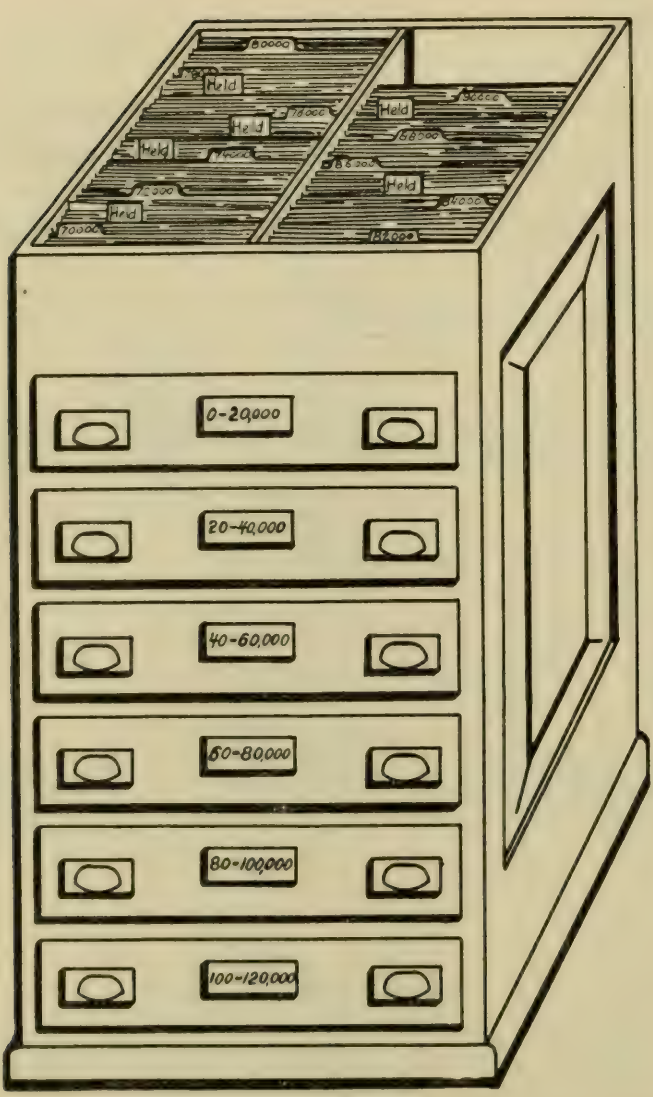


FIG. 7. FILING CASE FOR THE "SHOP" AND THE "COMPLETED" FILES.

The open card file at the top of the case or "shop file" (M, Fig. 1) has a capacity of about 4,000 cards and is used for all orders for which the specifications are complete but the shop work incomplete. Of the cards illustrated in Fig. 8, D, E and F should be filed in the "shop file." The drawers in this case form the "complete file" (N, Fig. 1) for all orders upon which final shipment has been made. The record cards in both of these are filed numerically.

Figure 7, where it is also filed numerically.

The staff of Division C consists of about 60 persons and the number of orders usually in the wall rack is 200 to 400, while the number of orders received each month varies from 300 to 400. The production clerk whose desk is directly in front of the wall rack is able to answer inquiries relating to orders very quickly. It is nothing unusual for the number of these to reach 75 per day, and many persons, after the first few times, consult the records themselves, especially if the production clerk is occupied. If necessary, they consult the key to the diagram posted, for their convenience, at the side of the wall rack.

This record was intended to economize the time of engineers and draftsmen by keeping for them, in the shortest form possible, an accurate record of the work assigned to each which would prevent their overlooking any order, and also to prevent interruption of their work by questions which could be cared for more efficiently by a central information bureau. It not only performed these requirements satisfactorily but also proves to have a noticeable effect upon the staff due to the publicity secured for the records. Persons having a number of orders which they have found difficulty in completing rapidly were much more concerned over that fact after the record cards were filed in the wall rack than they were before. Without any additional pressure from the executive it actually reduced the number of current orders in the department, permanently.

Accurate information, instantly available, at times proves very effective, as for example when a person from another department, who is very angry because an order is "held," is informed that the "hold" was placed upon the order in accordance with his instructions contained in letter of May 19, that the customer's approval must be secured before the work is carried further. While this record not only proves to be an assistance in preventing delays within the division, it is equally valuable in reducing the friction between departments as it allows the responsibility for delays to be definitely fixed.

Some record of this kind is almost the only possible way for the executive to gain, daily, a definite idea of the work in the department. Ten minutes, in this case, is sufficient for him to select those orders which are not progressing satisfactorily and to which he wishes to give his personal attention. Perhaps for that very reason the wall rack is found to have a most surprising effect in keeping the work "cleared up."

THE DESIGN AND CONSTRUCTION OF INDUSTRIAL BUILDINGS.

By D. C. Newman Collins.

THE establishment of a new industrial enterprise, or the extension of one already operating, is fundamentally a matter of investment, depending upon its future earning power, its initial cost and the cost of maintenance. Success depends upon an intelligent analysis of a multitude of details in advance of actual purchase and construction, the governing considerations being efficiency, low cost, and permanence. Blunders are easily made, they are expensive to correct and frequently impose a perpetual tax upon the future profits of the enterprise.

This is a progressive age in which the competitive procession is gaining speed with every step. It is not a matter of choice that we keep pace with it; we have to, or be trodden under foot. An industrial manager is confronted with the rigid condition of his selling prices being limited by his competitors', but he does not find the same limitation in his operating expenses. In fact, as time goes on he finds market prices lowering and the cost of production increasing. Labor demands are becoming more arbitrary and indefinite, more expensive and less subject to control, and yet labor is the factor controlling the quantity, quality, and cost of his factory output. Probably the most expensive and important item in manufacturing lies right here; manufacturing may be done by machines, material may be produced chemically, supplies may be handled mechanically, power devices may be used in carrying, transporting, and shipping product, but in every system, whether ancient or modern, the commanding factors are the brains and brawn of the operatives. Not only is the cost of production dependent upon the proficiency of the human equipment, but the grade of product, on which depends the standing of the firm in the commercial world, is dependent upon the quality of labor employed.

The general recognition of this fact is shown by the vast amounts of money expended for machines and devices for saving labor. Fortunes are invested simply to cut down the number, and increase the capacity, of the men. A comparative glance at an old and a modern shop will show the latter to be characterized by the absence of men and the substitution of ponderous machines. In many cases one man can now do an amount of work impossible for twenty without this mechanical aid, and he can do it faster and better. It requires $25,000 invested at four per cent to maintain one man in service at $1,000 per annum; if his output capacity should be hampered by discontent, poor air or light, miserable sanitary conveniences or gloomy environment, it is equivalent to a corresponding loss in working capital. On the other hand, if the same man is in good physical trim and mental condition and is contented, he can do better work and more of it. If a machine or mechanical device can be introduced to double this man's output, it is not a difficult problem to compute how much can be spent on it as a good investment.

It seems only fair to assume that a close study of labor is fully as important to the success of any enterprise as an investigation of the mechanical possibilities. An incapable, negligent or inefficient workman is not only a loss in the wages paid him but he holds up machine energy as well. A machine is a willing tool if installed and used with judgment, skill, and care. Poor alignment, improper adjustment, and dry bearings are traceable directly to an inattentive workman who has neglected this important element of efficiency. This inattention may be caused by discontent or mental hostility toward the management, due to the indifference of the manager to the needs and requirements of the workman.

To insure the best results the entire system must be harmonious and co-operative. The mechanical equipment has an output limited by the diligence and skill of the human equipment and both are subject to the supreme judgment and co-operation of the management. Harmony, co-operation, and system are the essence of industrial success; and in laying out industrial improvements, the manager accountable for the proper expenditure of vast sums of money has a responsibility upon his shoulders that warrants the expenditure of a small amount in obtaining skilled backing and advice, to promote an intelligent and thorough consideration of all these points and to check extravagance and error. The presentation of an enterprise in such clear shape as to bring up all points for discussion is, in itself, sufficient ground for payment of an expert fee. One idea incorporated in the work at the right time may have an earning power greater than the entire fee charged.

The laying out of an industrial plant cannot be governed by set rules, except that it is always best to know, before launching the project, exactly what you are going to do, to make sure that it is right, and to know positively what it will cost and what it will earn. Every industry has its individual peculiarities to be met and the tedious discussion necessary to a proficient analysis of all points takes time and careful study. In starting a layout we are confronted with an indefinite mass of details, one dependent upon the other and all of such importance and yet of such an indeterminate character that progress, even by a skilled specialist, can be attained only by careful comparative studies combined with a knowledge of prevailing prices, market conditions, and the suitability of various materials for the purpose.

Industrial buildings should be designed to form a single unit when combined with the equipment; should be developed together with the mechanical layout and criticised by a rehearsal of methods of operation at different periods of development. The buildings can attain their maximum degree of efficiency only when they have been designed for the work in view, and do not come under the classification of "Architecture" as it is generally understood. Ornamentation does not earn money; embellishments are useless; frills are superfluous, and all are an unwarranted expense. The relief given in the treatment of these buildings, on the outside, should be limited to such requirements of the structure as tend to give it strength, firmness, permanence, and an appearance that will evince comfort and common sense. The inside, however, is much more important as an earning factor.

Preliminary Work.

The difficulty of making the first step is well met by an approximate block plan incorporating the natural resources of the locality and a rough tentative scheme of operation. This report should be comprehensive and accurate, although approximate. It should cover, in a general way, the entire proposition, embodying a skilful presentation of the whole matter that will dispose of many indefinite details and simplify the decision of others by concentrated discussion.

This preliminary report should necessarily be accurate as regards estimated costs. The personal interest of an engineer should never affect his reliability, and he should quote prices that he can back up, and give estimates that will not invite too small an appropriation. Too often is an owner influenced into beginning an enterprise with insufficient funds to complete it, and when too far involved to withdraw is compelled to provide more money and ruin his investment. The selection of an engineer is entirely a matter of confidence in his integrity, loyalty, and skill.

In laying out new plants it is very essential to begin on a plant of much greater size than is required for present purposes, in view of future extensions. Too often is an owner compelled to abandon a plant and build entirely new because of the impossibility of accomplishing good results by erecting around existing buildings. A large plant layout may be started and only such parts of it actually built as are required for immediate occupancy, leaving connections and details ready for adding extensions without the unnecessary expense of tearing out and patching. The remodeling of an old plant to avoid interruption to existing crowded conditions is a special study, presenting a great field for resource and genius.

The preliminary report should be based upon an actual layout of the different departments, using approximate areas in order to shuffle them around until the best operating sequence is obtained. The method is tedious but the results form the best possible grounds upon which to begin work. Upon this layout fairly accurate estimates of the cost of the buildings can be made, and machines may be located; a mental rehearsal and discussion of the operating system is promoted from which improvements are recorded. To make it complete the report should give the close cost of buildings of the most suitable dimensions, details, and type of construction to fulfil the requirements and should also supply the discussion with approximate costs of other types of construction and styles of buildings so as to simplify rather than control the manager's efforts, and to promote a quick and decisive settlement of the essential points to be considered. The manager is then fully equipped to measure his investment, gauge his appropriations, and decide when and how to proceed to the successful accomplishment of the enterprise. He has a brief layout upon which to base criticism and invite suggestions. The opinions of his staff can be recorded and the probability of mistakes greatly lessened, before he has begun to spend money and while still in a position to withdraw if he finds the cost of the enterprise too high to be profitable.

A thorough preliminary study of an industrial project cannot be taken up too early. It costs no more to do it at one time than another. Such studies frequently prove of great value in checking and verifying the suitability of a new site for the purpose before purchase, and in illustrating the application of the geographical conditions and natural resources of a property to the particular requirements of the case. Every manager has a rough idea of his needs and should never lose control of the details of their accomplishment, but he rarely feels secure until his ideas are expressible to others for the criticism and discussion which are the best possible means of locating faults.

The limitations of this article will not permit of an exhaustive treatment of the mechanical and general equipment of an industrial project but will confine it to the commercial achievements of economic construction of the buildings, and the ethics of contracting.

TYPE OF BUILDING.

The type of the buildings is usually fixed by their suitability in simplifying the method of production as well as the convenient and rapid handling of material during the various processes of manufacture. Where heavy material is handled it is generally desirable to keep it near the ground in one-story buildings, and a careful study of the loads to be transported will show whether the desired results can be obtained by good timber construction or will necessitate the use of the more expensive concrete or steel. The material of construction will be affected also by the accepted method of handling material. A thorough analysis of transportation methods is a very important item, and an intelligent start on the buildings is impossible until this has been made. Where the material is light and the operating process will permit, a building of two or more stories may be selected, thus effecting an economy in lot area as well as a general saving in power transmission, heat, etc. The principal value of preliminary work concentrates right here, in measuring the efficiency and cost of the various labor-saving devices and in combining them with their contingent effect on the cost of buildings. The selling price of a device may show it to be a good investment but its effect upon the cost in building may make it look different. The consideration of these items should be finished before the buildings are developed on definite lines.

The next consideration is the industrial sequence of operation and the approximate area required for each department, from the receipt of raw material to the shipping of finished product, the idea being to have the general current of operation flow in one direction and to avoid the return of any material toward the place of beginning. A study of these features permits of a determination of the loads imposed upon the building and a much more intelligent consideration of ventilation, light, heat, and the location of sanitary conveniences. It also affords a basis for the proper consideration of fire hazard. The elimination of fire risk not only effects an economy in insurance premiums but it also reduces the possibility of an interrupted business. Insurance may cover a fire loss of plant and material but rarely provides for the loss in future business or the damage due to broken promises and the impossibility of filling orders.

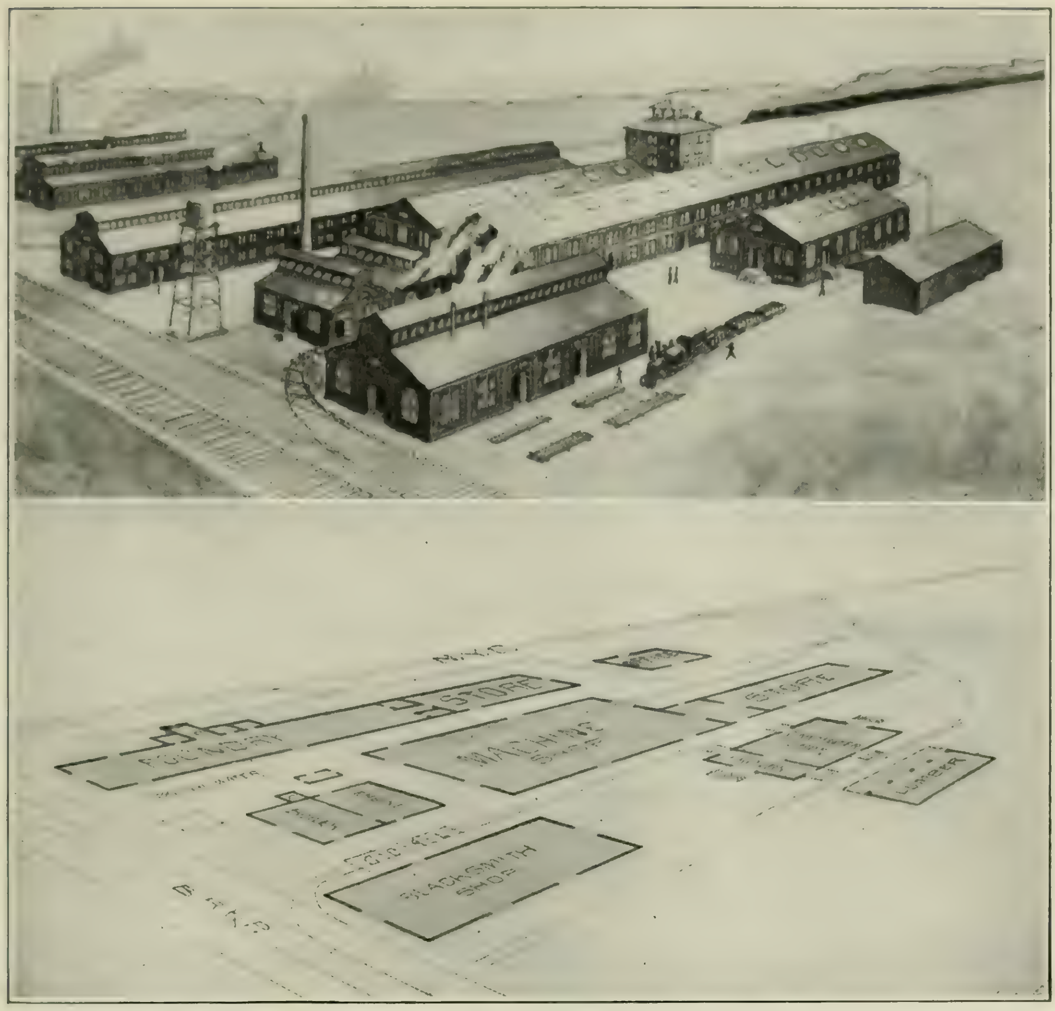


FIG. I. PRELIMINARY SKETCH NO. I. A LIGHT SHOP ARRANGEMENT.

When the weight of material handled is too heavy to be transported by truck, trolley, elevator or conveyor, it generally demands the introduction of overhead electric traveling cranes, and unless other considerations predominate will recommend one-story buildings, but it does not necessarily imply that all buildings should be one story. In many instances one, two, or more galleries have been enclosed under the same roof with the cranes, for the convenient location of the lighter machines adjoining the crane-covered floor area. Certain departments may be under separate roofs and the building may be made several stories high if proper arrangements can be made for transferring material from one to the other.

The question of grouping many departments under one roof is one that affects the layout, first cost, and fire hazard. Where the product is non-inflammable, and the operations permit it, many departments may be grouped under a single roof without dividing walls, and great savings in the initial outlay may be effected without any great increase in the risk, providing the buildings are reasonably fireproof. When the stock is of an inflammable character or the buildings, by requirements, are not necessarily fireproof it is better to separate the departments by fire walls and under separate roofs and the smaller the floor area in each department the less the liability to general conflagration.

Preliminary sketch No. 1 shows a plant for manufacturing a light product where considerable quantities of wood are assembled in the machine shop together with iron parts. No cranes are required except in the foundry and in the center span of the machine shop; a brief description will illustrate why the buildings were grouped as shown and why the cost of additional brick walls is warranted, rather than a more general grouping under one roof.

This foundry does mostly duplicate work from stock patterns, which fact permits of its separation from the carpenter shop and pattern shop, and the protection from gases from the foundry, together with the fire risk of combining it with the above mentioned shops, were deemed sufficient to recommend its separation from the other buildings. The blacksmith shop is separated for the same reason and is brought nearer the carpenter shop for the reason that the smith work is largely applied to wood and the shops should be in direct touch.

The machine shop has a gallery for light machines around the assembling floor, which is covered by crane; the machine store is equipped with a similar gallery, and the paint shop, between, has two floors. It can be readily understood why this building should be separated from the others. The power house and pumps are combined under one roof and are separated from the other buildings.

Preliminary sketch No. 2 shows a rough layout for the manufacture of valves. The office, pattern shop, pattern storage, and the power house are separate as a matter of fire protection, to effect the general separation of labor, and for the comfort and convenience of workmen. The departments in the main building are separated by fire walls and automatic fire doors for fire protection, and the operation of the plant causes a natural flow toward the shipping rooms without obstruction. The classification of labor in this layout is beautifully provided for as all material and work can be charged against one department until the product is turned over to another, when it can be credited in regular sequence and charged to a customer on shipment.

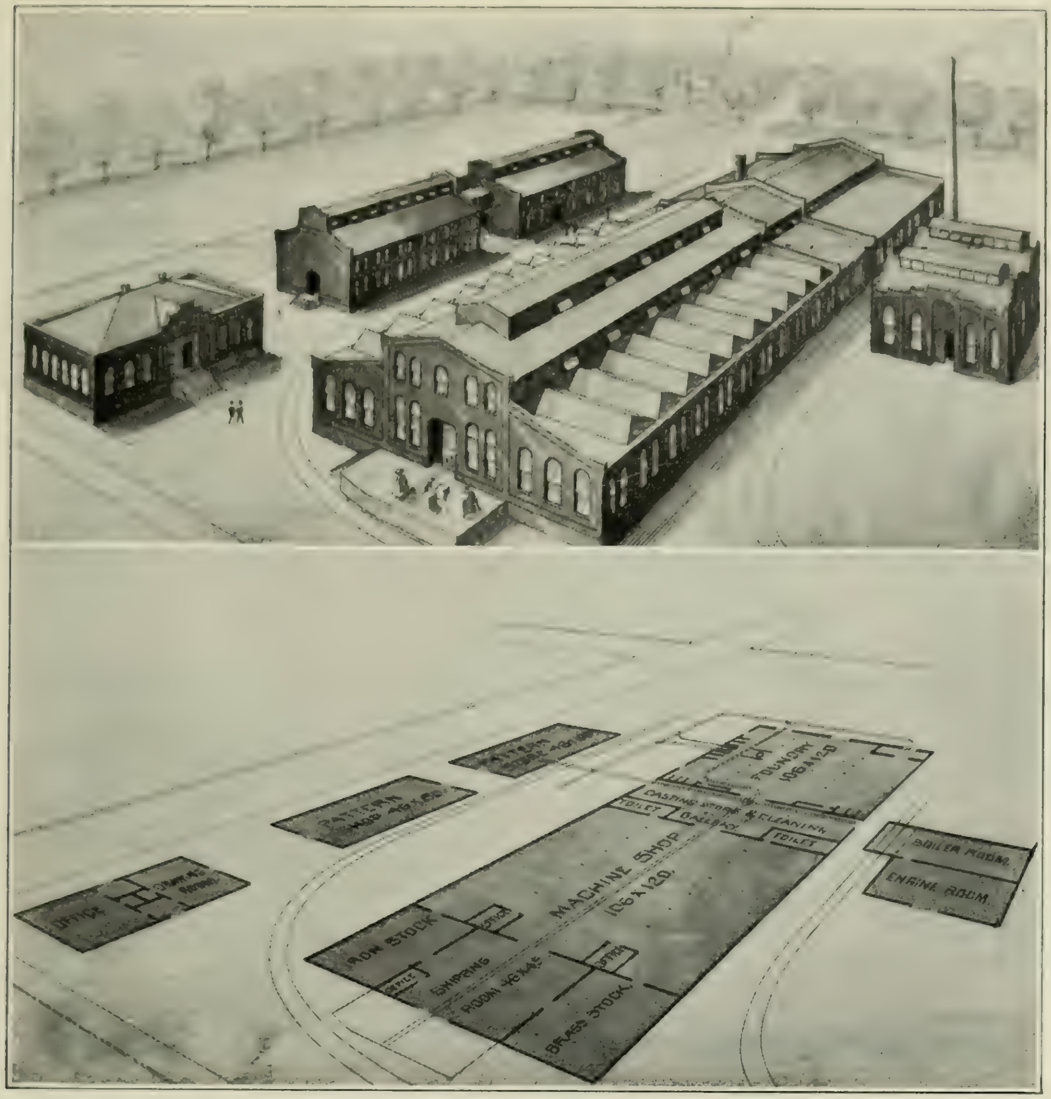


FIG. 2. PRELIMINARY SKETCH NO. 2. A SHOP FOR THE MANUFACTURE OF VALVES.

The machine shop, cleaning and storeroom and stockrooms, are built with galleries to economize space. The additional cost of separating these departments would be in an extra brick wall and foundations at the end of each, as well as in the transporting of all material a much longer distance, with additional cost of plumbing and heating due to the separation of the departments and the duplication of sanitary conveniences.

Preliminary sketch No. 3 shows another study of departments under one roof and yet isolated. The establishment is for manufacturing stationary engines and boilers. The foundry and power house are absolutely separate; the other departments are in direct touch with the erecting floor and yet can be separated where advisable to protect against fire. The sequence of operation here can be unob-

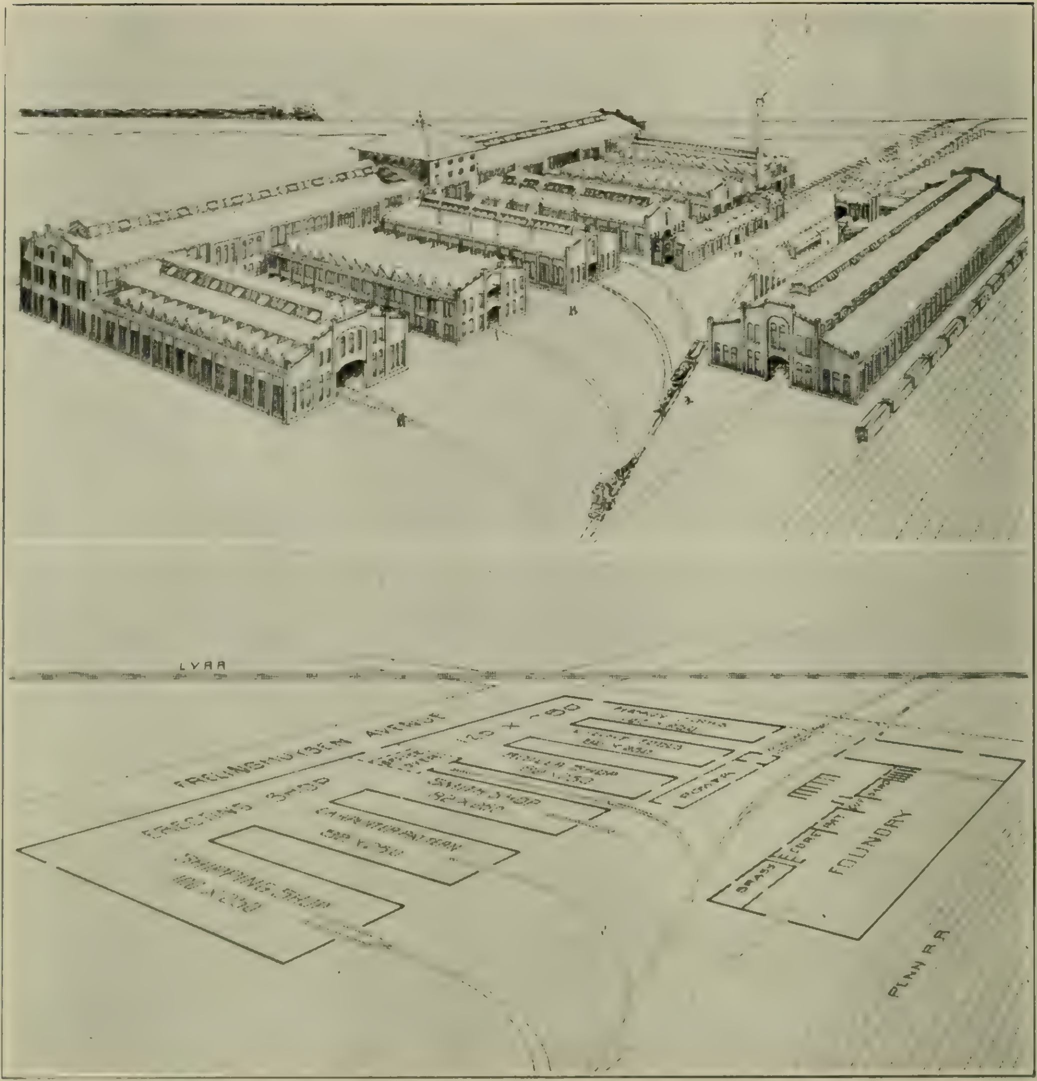


FIG. 3. PRELIMINARY SKETCH NO. 3. AN ENGINE AND BOILER WORKS.

structed and direct to the shipping room, each department contributing its share during the trip.

Passing to the other type, multi-story buildings, where the product can be handled readily by elevator, truck, or trolley, we have preliminary sketch No. 4, a spinning mill. The departments here are much larger and fewer in number and the departments are studied to suit more the dimensions of the machines than any special classification and separation of the work. It is permitted here to make a roof of each floor above, which effects a great economy in first cost. On account of the radical difference between the duties of the mill and dye-house, and the desirability of plenty of light and air in the latter, the two buildings were separated.

Preliminary sketch No. 5 shows another type of building with several stories, for the manufacture of insulated wire cable. Upon investigation, it was found most economical to put all departments under one roof and to lessen the fire risk by a fire wall and automatic fire doors. Fire hazard in buildings such as Nos. 4 and 5 must be very carefully looked after, both in layout and in details of construction. It will be noticed in both of these buildings that all elevator shafts, stair towers, and other vertical flues connecting the various floors are separated from the main floors by fire walls and automatic fire doors. In buildings of an "L" shape like No. 5, all windows opening in the "L" are safe if made with wire glass and metal frames, or automatic fire shutters, to prevent the passage of fire from one wing to the other. No openings from one floor to another are allowed in the main building unless they are protected, all communication being made through

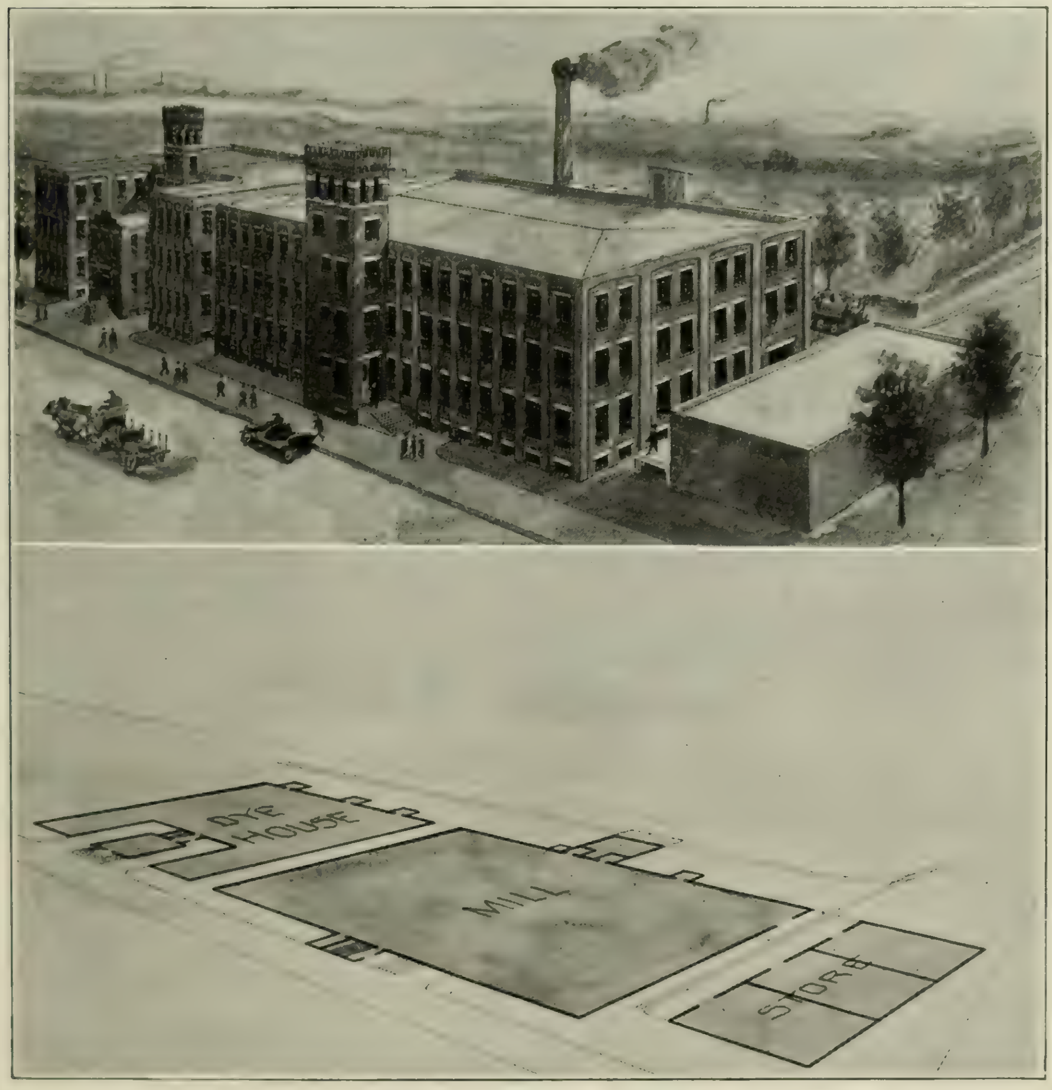


FIG. 4. PRELIMINARY SKETCH NO. 4. FOR A SPINNING MILL.

one of these fire towers. Automatic sprinklers prove a great safeguard in buildings of this class. They open up at the first appearance of excessive heat and sprinkle until turned off. To lessen the liability to fire damage, floors should be so built into the brickwork that in case of fire the falling of floors will not trip the walls and remove the protection to adjoining buildings. In many well constructed buildings, the floors have burned out completely leaving the walls standing in good shape for the support of new floors.

Construction Material.

In deciding upon the best material to be used in the construction, a careful canvass should be made of local resources and prices of building materials, labor costs, speed in construction, and the limitations of local artisans in the diligent and proper execution of work. Rigidity, permanence and the cost of maintenance are important elements to be considered, and the ultimate decision should report recommendations for material most suitable from both a commercial and an industrial point of view.

The development of the buildings should be unprejudiced by any interest the engineer may have in any special brand of building material or in any contracting concern. He should be perfectly free to recommend the material best suited to the purpose and to direct the proper purchase unhampered by the claims of any interest outside that of his clients. Engineers are educated and trained to accomplish satisfactory results in the best manner and for the least money. Anyone can do great things with unlimited money and it does not require great skill to do cheap work. To decide exactly what is wanted and to buy it right, however, is a different matter, and the measure of results in dollars and cents will be in proportion to the technical skill and the commercial energy and talent applied to the work.

Kind of Building.

The general construction of industrial buildings may be classified under six headings, each type having advantages and disadvantages, distinctly its own.

1, Timber Construction,
2, Timber and Brick,
3, Reinforced Concrete,
4, Steel Construction, Metal-Covered,
5, Steel and Brick,
6, Steel and Brick, with the Steel Wrapped or Fireproofed.

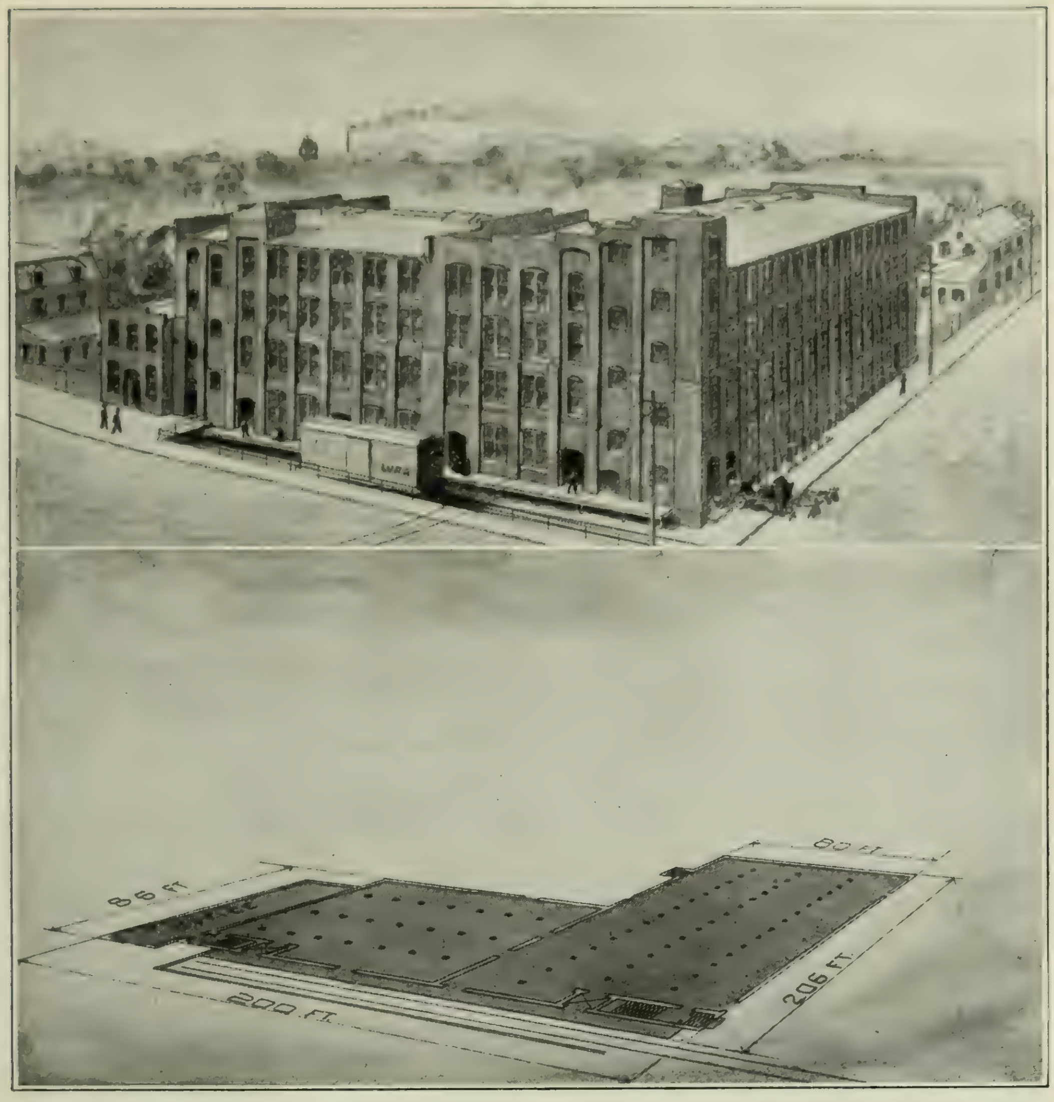

86 FT.
80 FT.
200 FT.
206 FT.

FIG. 5. PRELIMINARY SKETCH NO. 5. AN INSULATED WIRE CABLE PLANT.

The cost of the structures will run in about the order named, timber being the lowest and fireproofed steel the most expensive. There are of course, many combinations of the above mentioned materials that can be used, but for the purpose of this article these headings will serve.

Buildings built entirely of wood are usually adopted where permanence, rigidity, and fire hazard are of small importance. In permanent structures timber is used mostly on temporary work, because if used in a permanent structure the cost of maintenance would be very high and the building would be easily destroyed by fire and subject to early decay.

Timber and brick is much more satisfactory as the woodwork can be sheltered from the elements and preserved for many years if

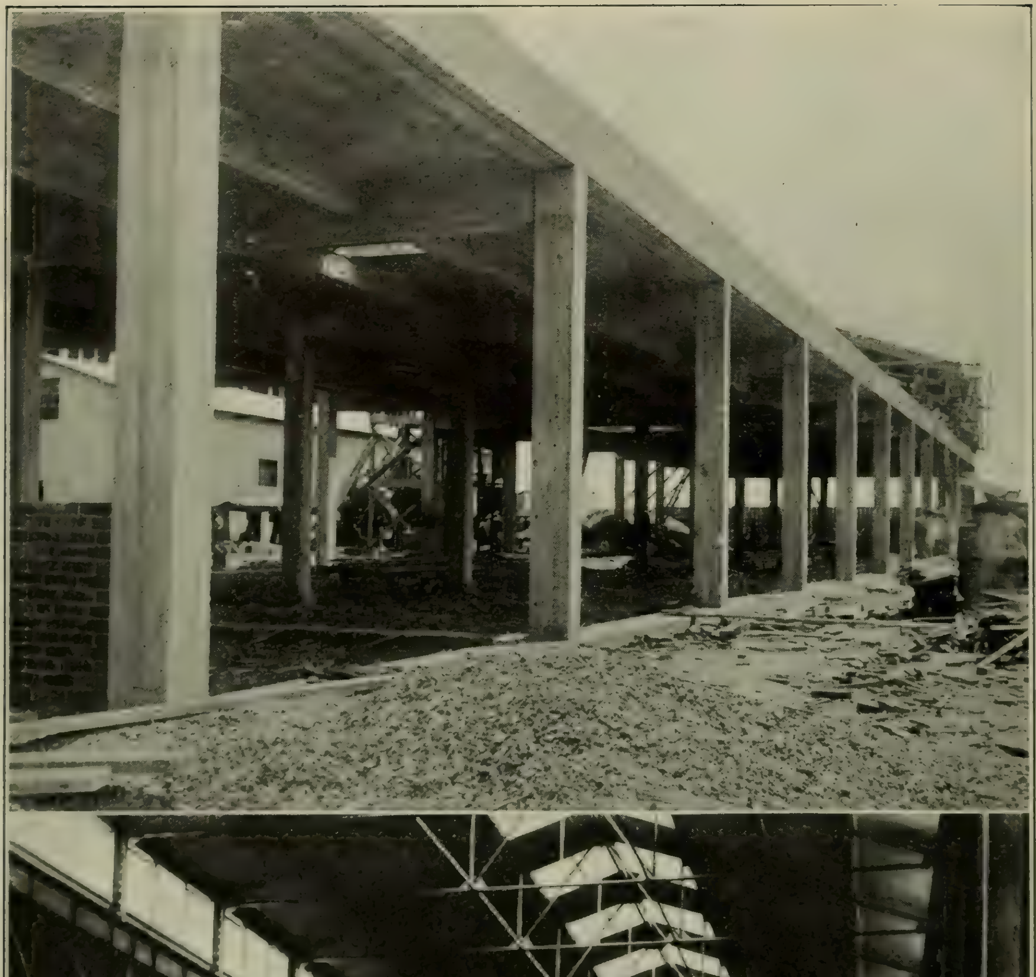


FIG. 6. FOUNDRY BUILDING OF STEEL AND BRICK, WITH CONCRETE AND PILE FOUNDATIONS AND SLAG ROOF.

The interior view shows traveling-crane service. The group contains also a two-story pattern-storage building, with reinforced-concrete walls filled with brick.

properly constructed. The low cost of this type of construction recommends it very extensively for buildings of several stories, and a well constructed "mill constructed" or "slow burning" building is eminently satisfactory for certain purposes. In its construction, however, there are many things to guard against, such as dry rot, dampness, distortion from shrinkage of timber, and the spread of flames before the sprinklers or fire apparatus can control them. The theory of insurance recommendations is not that the structures do not burn, but that they will burn with as little damage as possible and so that they can be rebuilt for a very small outlay.

FIG. 6A. EXTERIOR OF PLANT SHOWN IN FIGURE 6.

They are most convenient for the locating and anchoring of machines after completion of the building. The matter of excessive vibration, so troublesome to many owners, is due generally to faulty design rather than to insufficient material. I have had occasion to investigate the matter of vibration in some of the largest mills in the United States and Canada, and have found the cause invariably to be that the timber had a span too great for its depth or thickness. In regard to the strength of timber, a liberal factor of safety should be used on account of the indefinite character of the material. Timber is looked upon as the simplest kind of construction and it is fre-

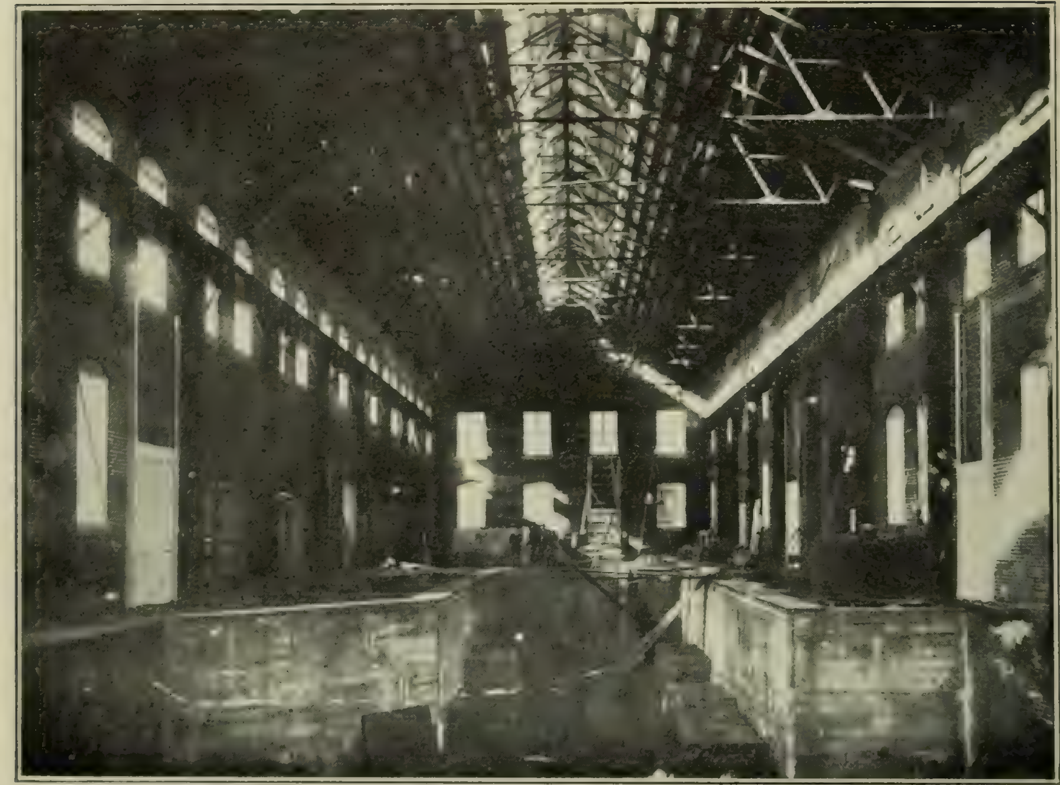


FIG. 7. PIPE FOUNDRY. STEEL FRAME, SLATE ROOF, BRICK WALLS AND FOUNDATIONS, CONCRETE CASTING-PIT WALLS.

Three traveling cranes on same runway, one for casters, one for moulders, and one for core makers.

quently put up from designs of a carpenter. In making extensions to old buildings that have been used for many years, an investigation of the loads placed upon the old floors has called attention to startling conditions of overloading of timber construction. I have failed to find any theory or practice that would prove their ability to withstand such excessive stresses, and have in some cases refused to duplicate the old design in the new work. Such perilous conditions may be due to faulty design, to imposing more severe duties than were ever intended, or to the fact that modern timber lacks the strength of old-time stuff. At any rate it is better for an engineer of reputation to stand criticism than to sponsor a design that may cause disaster. Timber and brick buildings when used with good judgment and handled properly are very pleasing, cheap and convenient and can be erected quickly in any location.

Reinforced concrete has fire-resisting qualities, permanence, and rigidity unequaled in any other type of construction. All designs for reinforced concrete are based upon the assumed strength of material to be manufactured at the site and upon the accurate location of the reinforcement in the position shown on the drawings. For this reason it is important that the field details should be inspected carefully by the designer to insure a homogeneous execution of these essential features of the design. When such care is taken in steel structures to have all details fixed and checked by skilled engineers and also to have the work inspected in the mill and shops, the precedent established by long experience should be observed in reinforced concrete construction also. The beauties of concrete construction are best brought out by an administration incorporating good supervision, careful inspection, experienced management, and modern power equipment for executing the work. It should never be entrusted to amateurs.

The cost of reinforced-concrete structures is dependent upon local market conditions, labor proficiency and the required speed in construction. The building is first produced in wooden negative to mould the fluid mixtures to size and shape. The steel is then placed in proper position and the concrete poured in the moulds. The concrete is then allowed ample time to develop its strength before the removal of the forms in order to reset them for another pouring. A recent case where convenient shipments of material was possible

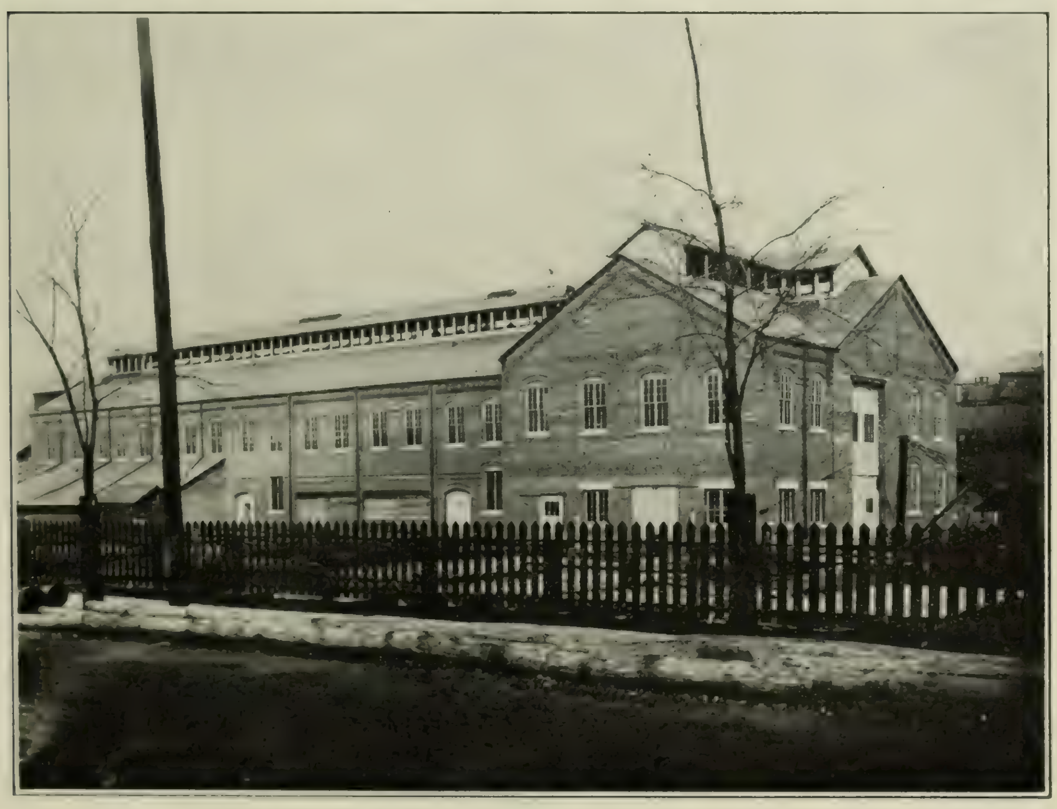


FIG. 7A. EXTERIOR OF FOUNDRY SHOWN IN FIGURE 7.

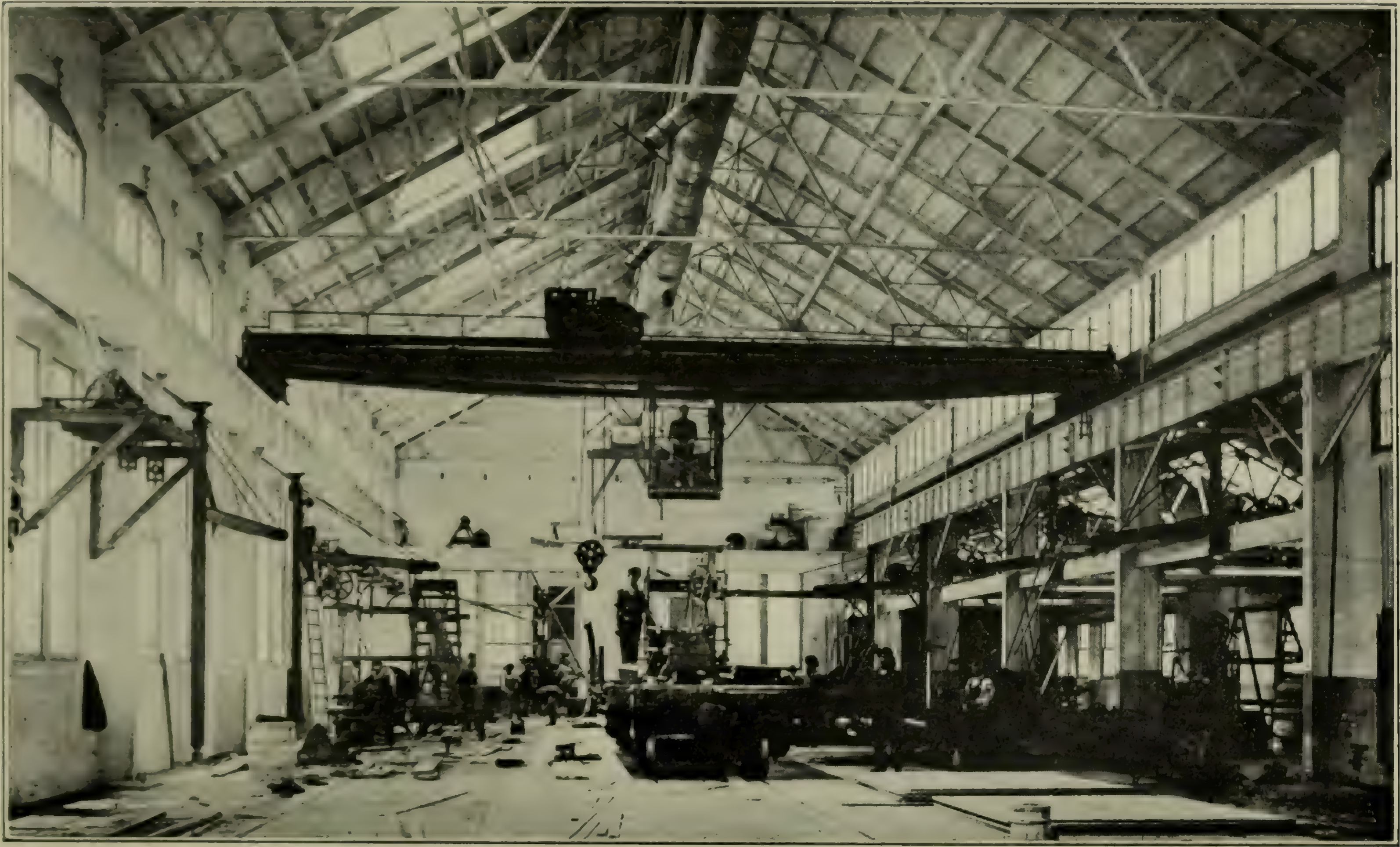


FIG. 8. HEAVY MACHINE SHOP. CONCRETE FOUNDATIONS, STEEL FRAME, BRICK WALLS, TAR CONCRETE FLOOR WITH MAPLE PLANKING TOP.

Note excellent lighting, and location of individual jib cranes for large tools. Driving motors are installed overhead, on platform, or in the roof of the lean-to.

by railroad direct to the building and where the time of completion permitted the resetting of the forms once illustrates the comparative cost of labor and material involved and the importance of good generalship in concrete construction. The cost of the material in the concrete alone amounted to 19 per cent., the cost of steel reinforcing delivered at the building 17 per cent., the total cost of labor 31 per cent., and of lumber for forms 33 per cent., of the total cost of the concrete frame of the building. From this it can be seen that nearly 2/3 of the entire cost of the work is in the items of lumber and labor alone. The costs of concrete material and steel are largely fixed by market rates and the cost of lumber for forms and of labor will be measured by the suitability of the design to the character of material used and by the judgment and diligence of the executive management.

As regards speed in construction, the cost will increase with the quantity of lumber used in the forms. The frequent resetting of forms will save lumber but requires more time. The nature of concrete is such that it requires time to develop its strength. Concrete in large masses dries slowly and its strength grows more slowly in cold than in hot weather. Its setting cannot be hurried beyond a certain point and an owner should temper any possible impatience by an appreciation of these facts. Concrete should be poured and finished in one operation without separate finishing of surfaces and when this is done it is practically indestructible by fire or acid. Its strength grows with age. Concrete is the best known agency for the protection of steel and it expands and contracts under the effects of temperature changes about the same as steel. Hence, there is no reason why any reinforced-concrete building, if properly constructed, should not withstand the ravages of time and tempest unharmed.

Steel construction is usually adopted where the requirements of the structure exceed the advisability of using timber or reinforced concrete. The fire hazard is small where the manufacturer's supplies are not inflammable and it is very safe from damage from adjoining fires. The metal covering of steel is generally a matter of very doubtful economy as it presents no stability to the structure and the bracing introduced in the steel frame to resist wind pressure, etc., on that account will add sufficient cost to it to put in a good wall. At best it is very perishable and liable to deterioration from the action of the elements or from gases and hard service.

Steel and brick construction for heavy structures comes in a monumental class for safety, reliability, and rigidity. It has no su-

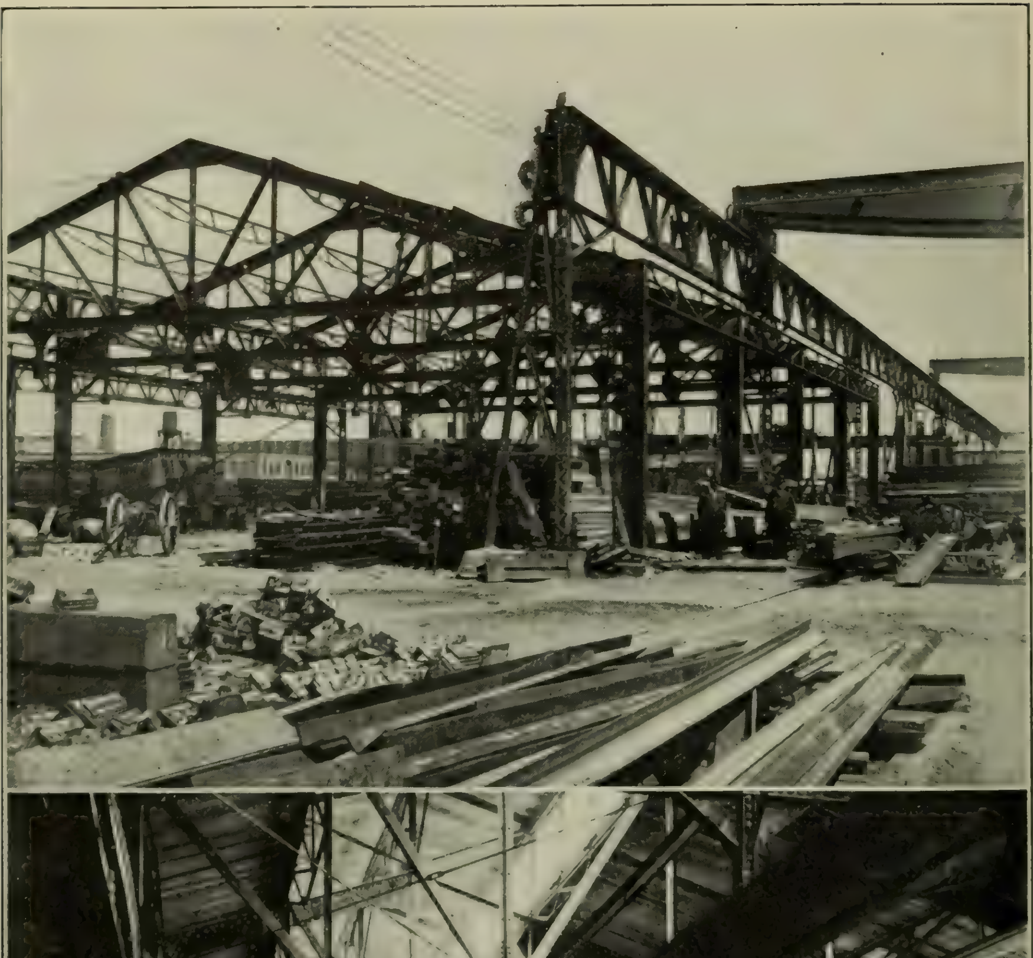


FIG. 9. STEEL SKELETON AND FINISHED INTERIOR OF BUILDING FOR MANUFACTURE OF STRUCTURAL STEEL.

The roof supports several short-span cranes, running longitudinally to feed machines, and the main posts carry also a yard crane for handling steel stock.

perior in permanence and strength and its stability can be impaired only by heat sufficient to melt it down or the action of the most destructive acids or gases. It can be made to do the most severe and extensive work safely, for its strength is a definite and known quantity. In steel construction the dimensions of every piece of material and the numbers and location of all rivets and bolts in the structure are calculated and checked by skilled engineers while making the designs and shop detail drawings. Nothing is left to the discretion of the field force except to assemble the pieces and fill the holes provided, with proper bolts and rivets. This eliminates any speculation as to the actual strength of the structure, particularly when the material is inspected during every process of manufacture.

In steel structures where the contents are inflammable or it is desired to guard against damages from a general conflagration, the steel is enclosed in fireproof materials as an extra safeguard and protection. When well done with proper material, this probably represents the best known type of heavy construction. With the exception of reinforced concrete, it has no equal in permanence and fireproof qualities and it can be relied upon to do the work required of it.

When combinations of the above mentioned construction materials are desirable, only an engineer having a thorough experience with them is well equipped to select the combination most suitable from every point of view.

The Commercial View of It.

The material best suited to the purpose should be selected with just consideration of the requirements, together with recognition of the local resources and supply of material and the demands of local labor organizations. Every building project can be reduced to a matter of skilful purchase and proper delivery. Good purchasing organizations are equipped with a thorough knowledge of the market prices and conditions of delivery as well as the quality of material they have to buy. The foundation of good buying is broad and fair competition. There is only one way to get the full benefits of competition, and that is to establish exactly what you want to buy and how you want to have it delivered; tell the competitors all about it at the start, and let them all start on even ground and with no uncertainties to charge for. Whether the purchase is made in single items or *en masse,* this knowledge and record of details is indispensable to the intelligent handling of the work, and an engineer's office insufficiently equipped to direct the

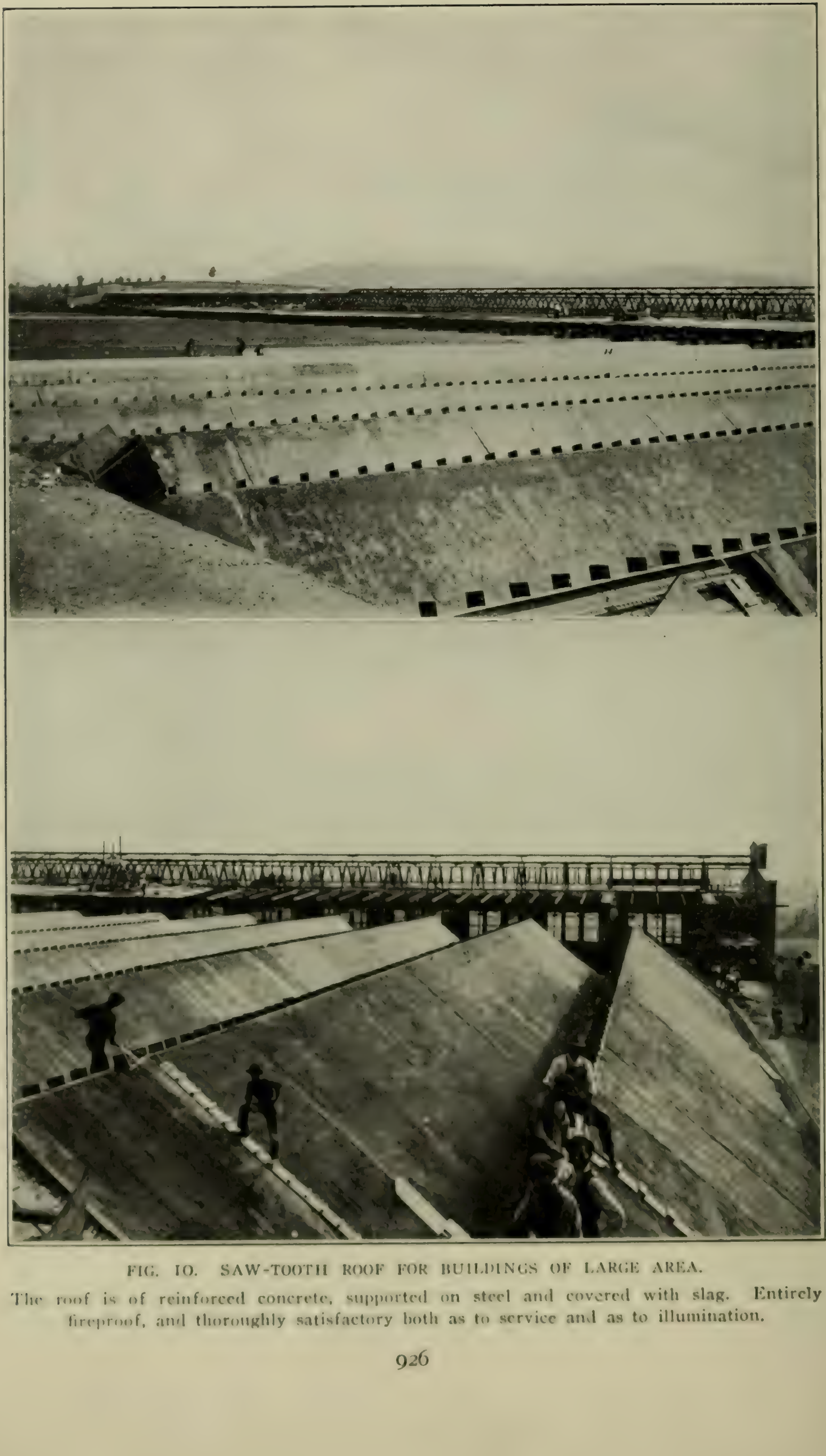


FIG. 10. SAW-TOOTH ROOF FOR BUILDINGS OF LARGE AREA.

The roof is of reinforced concrete, supported on steel and covered with slag. Entirely fireproof, and thoroughly satisfactory both as to service and as to illumination.

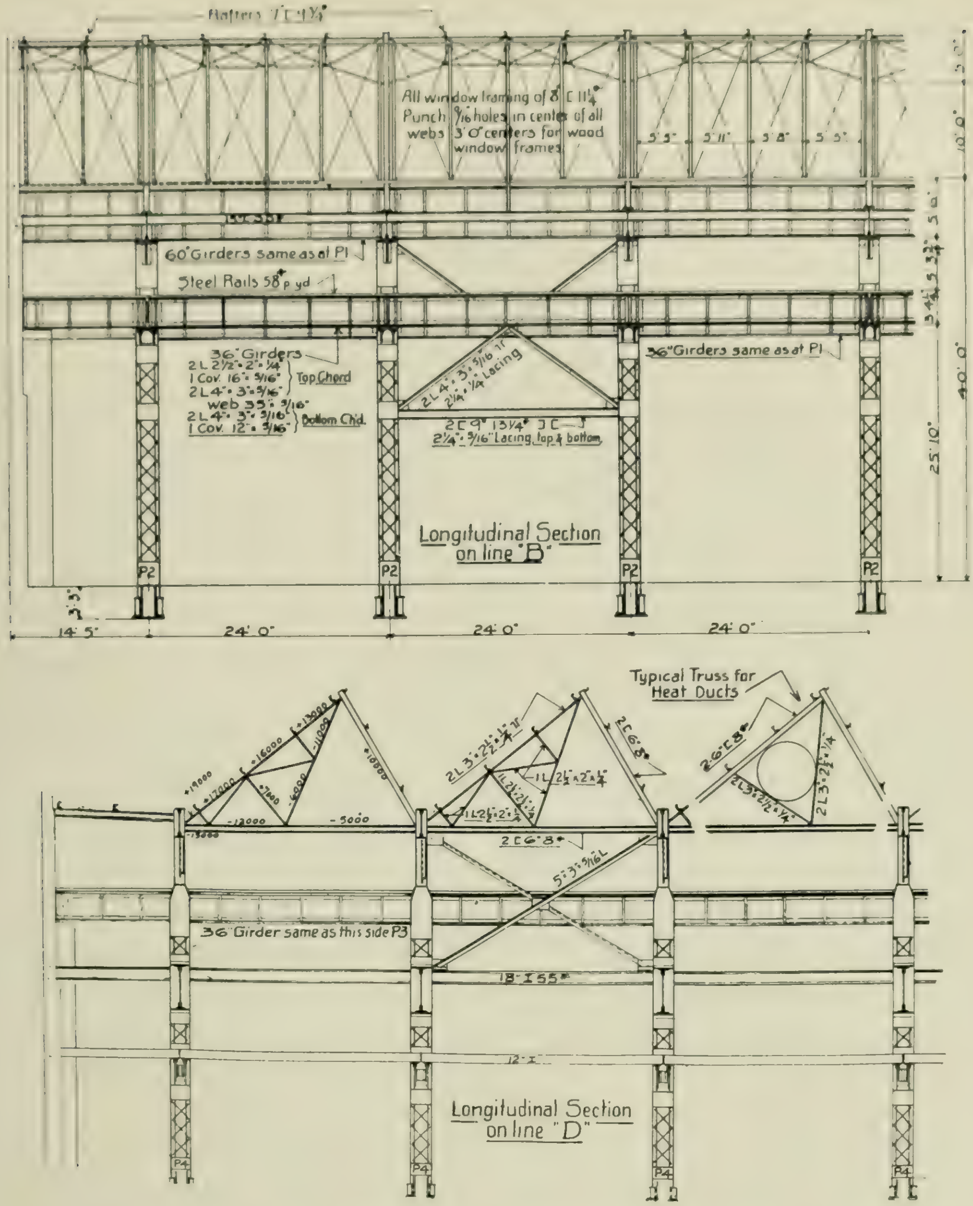


FIG. 10A. SHOWING STEEL WORK OF BUILDING ILLUSTRATED IN FIGURE 10.

purchase campaign on his own work is certainly in a poor position to back up his preliminary estimates and to serve his client fully. When a preliminary report has been completed with proper consideration of the industrial, technical, commercial, and physical conditions attending the work, the manager is well equipped to say intelligently when to go ahead and prepare for the execution of the work.

The plans and specifications are simply an accurate detailed record of the material to be bought and delivered. They are used in canvassing the situation and determining the best means of handling the work, and serve as well as a legal claim for its proper delivery.

With the preliminary work completed and the criticisms on it recorded, the regular drawings are made to scale and a record of the smallest detail is expressed upon them. The more thoroughly this work is done, the closer together the competitive bids will run. All uncertainties in quantity and quality of workmanship and materials should be studied and settled at this stage so that bidders will all bid on the same thing and the work can be controlled by price alone. In this way bids can be compared intelligently.

Method of Purchasing.

In buying building material there are countless methods and complications that are rarely duplicated. There are artists in every profession and trade, each offering what seems to be the most tempting proposal to get the work. It should be kept in mind always, that with complete plans, there is just so much material to be bought and just so much labor to be done, and the two together, under normal conditions, should cost just so much money. If an offer is made to do the work for very much less than it should cost, it should be looked on with suspicion. If a proposal comes in to execute it for a much larger amount, it should be put aside for a fairer method. Proposals are sometimes given in a single lump sum for the entire work, or they may be sent in as separate bids for each trade. Some will quote unit prices, so much per pound, per square foot, or per thousand, others will offer to do the work for a certain percentage of the cost, and may or may not give a limit of cost, and still others will agree to spend the money for a fixed fee and guarantee nothing, explaining that it is hard to beat cost prices. Some bidders boast that they will not estimate any work nor guarantee any costs, but will do the work for a fixed fee, penalizing that fee for any overrun above a fixed amount and taking a percentage of all savings made under that amount. Some bidders may propose to contract for labor only, all materials to be furnished by the owner—and so on in an unlimited variety, each one exploiting his own system as the only one to save the owner money. These various tenders do not affect the value of the work in the slightest, but it is a complicated matter to list them for intelligent comparison. In order to classify and assess each one for its true value, we come right back to the necessity of knowing all about the quantity, quality, and value of the material to be bought. The time of completion is another complication entering into the proposals. The higher bidders are sometimes the ones who make the best promises.

This is the period during which everybody is amiable and friendly, and makes all sorts of promises; it is also the time to nail down all loose corners. This campaign may show the lump sum to be the best, or it may show that the general contractors are all busy and the bids on separate trades show considerable economy. There are instances where changes are likely to be made during erection of the work and unit prices will permit unlimited changes without danger of excessive bills for extra work. There are times when a percentage form of contract will look good, or the fixed sum contract will have a special advantage. The success of the latter form of contract, however, depends largely upon the capabilities and diligence of the bidder in prosecuting the work economically. Unless he gives a guarantee there is no commercial inducement for him to put energy on it.

In cases where the early completion of the building is imperative it requires considerable ingenuity to assure it without paying a large premium. Very frequently the engineer prepares preliminary data from which competitive unit prices can be obtained and orders for material placed by the owner direct, without waiting for the plans to be finished in detail. In this way, material requiring considerable time to deliver can be ordered in advance and the plans be finished and other work prepared for its erection while it is in transit.

When steel contracts are placed direct at so much per pound, it is well to have the engineer prepare the detail drawings for the shop, in order to control the number of pounds. In lumber orders, the lists can be prepared by the engineer to control the number of board feet. When this is done the labor can be contracted for separately or by day work as conditions may recommend.

It should be borne in mind in splitting up contracts that there must always be a head to the administration of any contract to harmonize the varied interests, and a good superintendent acting under the engineer's instructions will fill the bill admirably. An engineer properly trained should be in a position to relieve the owner of all this worry and to protect his interests from beginning to end through any method that the owner's interests may suggest as being most economical. In this way, an engineer's fee becomes the best possible investment and cannot be looked upon as an expense.

It would require volumes of literature to cover a description of building details; they are unlimited in number and combination. In studying detail of an industrial building the principal consideration is always the execution of its functions as a manufacturing unit. Every inconvenience in detail acts continuously and effects a perpetual loss in operation. On the other hand, every perfection in detail will assist the steady flow of profits. Next to this in importance is keeping down the amount of material to be bought and the consequent cost of buildings.

A few photographs of different types of buildings may serve to interest readers as they will show the combination of many details that were decided upon in various instances.

Many owners look upon industrial buildings as mere shells to give protection from the elements. They treat them as a single item without consideration of the multitude of details that combine to make success or failure. Frequently an owner will consider competitive figures on a building of a certain size as satisfying all demands of competition regardless of the uncertainty of what each bidder includes in his estimate and in absolute disregard of the helpless condition he will be placed in after the contractor is bound to deliver him a building and he is obligated to pay the contractor a sum of money.

The interest of an owner is not to get the cheapest building possible; it is to get the right kind of building as cheap as he can. When an owner puts himself in the hands of a contractor who is experienced in his business, without knowing and having a clear record of what he is to get for his money, he is adopting poor business tactics as the interests are entirely divergent in every way and the obligations generally flat. An invitation to bid in competition, if taken literally, means nothing less than a challenge to execute the work with as little material as possible and with the least amount of labor that the specified requirements legally demand. After the contract is signed, these legal records of requirements are the sole grounds for protection to the owner.

The ethics of contracting are broad and varied. Every contractor and material dealer has his own individual ideas of successful business policy, and they seldom permit a loss to himself. It is easy for an owner to award a contract, but sometimes much more difficult to satisfy himself that he is getting the value of his money. The awarding of a contract closes that end of it and if the requirements are indefinite so will be the results.

This is not intended to reflect upon the integrity or honesty of contractors or material dealers. The nature of a competitive inquiry is a strict challenge to beat the other fellow, and in doing it he is virtually complying with the essence of the inquiry.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By C. U. Carpenter.

VIII. STIMULATING PRODUCTION BY WAGE, STOCK, AND COST SYSTEMS.

Mr. Carpenter's series began in January, and the six articles heretofore presented discussed, first, the general methods of examining into the condition of any manufacturing business so as to discover the existence of waste and loss and to determine the "sticking points"; second, the nature and the working of the "committee system" of factory administration; third, the reorganization of the designing and drafting departments; fourth, the great importance and value of the tool-room as a source and spring of profitable methods; fifth, the general conditions necessary for manufacturing at minimum cost; sixth, methods for fixing standard times for manufacturing operations. Seventh, minimizing the time of assembling.—THE EDITORS.

IN the preceding articles of this series, methods of determining with accuracy the shortest possible time in which any job can be done were fully discussed. There I dealt with the latest tables showing the best possible cutting speeds on lathes, planers, and drill presses, and also described methods by which the shortest possible time on intricate assembling jobs can be determined. Naturally, the determination of this "shortest time"—this fixing of the "standard time"—will prove of great assistance in the collection of prime labor-cost data on any and all jobs of work.

Before giving consideration to systems of cost-keeping or to the stock-keeping and stock-tracing systems which are interlocked therewith, it is important that we briefly consider the question of the *wage* system under which the men must work, and which to them is the all important feature of their shop life.

We manufacturers must keep in mind just what actual shop life and the wage system mean to a workman. We, who have crawled up the scale, now look upon a broader horizon of opportunity. We are not surrounded by those inexorable conditions which to a large extent absolutely regulate the life of the average workman. We are not subject to the whim of a job boss or assistant foreman, who holds his place perchance through favoritism or relationship to someone in power, and who looks with frowning mien upon any improvement which might be suggested and for which he may not get the credit; whose control over five-twelfths of daily existence is well-nigh absolute; who can make the daily work easy or hard, the daily earnings for the all important livelihood large or small, by apportioning the work unfairly. We are not compelled to work under a system of pay that provides no especial recompense for extra effort and extraordinary output, but which on the other hand often rewards (?) extra thought and extra skill and effort by a cut in the rate or "price," which leaves one working, perhaps, 20 per-cent harder than a few days before with a daily return in wages no larger than formerly—our job boss or foreman adding to the "pleasure of the incident" by proudly showing how he "cut that price 20 per cent, saved the company a large sum of money, and still 'gets the output.' "

Much has been written upon the subject of systems of pay and many broadsides have been fired at the old system of piece work, *coupled as it so often is with the practice of cutting rates when the men begin to earn large wages.* But it is far from being blown out of existence, for today the majority of factory managers still adhere to these methods. Understand me, I do not criticize the piece-work system *per se,* but I do strongly condemn, as unfair and uneconomical, the habit of cutting of rates when wages become high which almost invariably accompanies the system. In fact, I have found the same tendency to exist in the case of the premium and other systems of pay, in some cases. The mischief is very largely caused by the practice of setting "original prices" or "original times," not based upon data scientifically determined, but upon "best previous records," an ordinary "try out" or, worst of all, the "foreman's estimate." It is because of the importance of the system of pay and because of the inefficiency of the ordinary methods that I have tried, in the preceding paper, to lay down some principles or rules that may be a guide in securing proper results and in giving us a secure and accurate foundation upon which to build our structure of proper factory management.

We must ever keep in mind that recompense to the workman is only one part of our total cost. A largely increased production per square foot of floor area means lower cost through the decreased proportion of overhead or indirect cost per piece. Further, it means a much quicker movement of stock and thus a release of working capital through reduction of investment in stock. It means better satisfaction to selling department and customer through quicker deliveries, and almost invariably an increase in sales with a heavy decrease in cost of selling per article. The average factory manager will term this far-fetched; but any man who has reorganized a completely run-down concern, and built up the manufacturing, selling, and financial ends of a business, knows that there is nothing so vitally important to the success of the business, in every direction, as the quickening of shop production and the possibility thus secured of making a quicker turn-over of working capital invested. The average factory manager gives little thought to this, but the financial officers and backers spend many worried hours trying to make both ends meet and wondering "where all the money goes."

PROBLEM OF INTRODUCING "STANDARD TIME."

We may be sure that, having collected all of our data relative to standard times, we still have before us the problem how to introduce these—how to persuade the workmen to work to them, or in shop phraseology, to "stand for them." For you may be certain that if the work of determining these times is done accurately and thoroughly, the figures obtained will be so far below the results actually being secured in existing shop practice, that the workmen will, in all honesty, refuse to believe that it is possible to attain such rates of production; and indeed, we too, must keep in mind that the attainment of these standard times does not depend wholly upon the workmen, but very largely depends upon the efficiency of the factory management itself in many directions, such as supplying plenty of tools of standard shapes and hardness, proper machine tools and fixtures, and stock properly placed, as well as a method of instructions and demonstrations how the work should and can be done.

It is perfectly obvious that not every workman can possibly attain for some time the rate of speed necessary to do the work within the set time limits. It is equally clear that it is immensely to the benefit of the manufacturer for him to get the working time down to the points determined upon. A flat piece rate based upon these times is manifestly unfair, and an attempt to introduce such rates would probably lead to immediate trouble with the men. I am strongly opposed to any plan that does not provide some form of extra reward to the man for attaining the standard time, this form of reward or bonus to be assured to him with the guarantee that no reductions will be made unless methods, process, or tools be changed.

The method of pay and character of the reward will depend upon the character of the business and the method of pay already in use. I have never favored the forcing of any preconceived plan of any character upon a factory organization or system, if it carries with it the necessity for ripping up existing methods and plans that have become a part of the factory's very daily existence. The old method, the old systems, possess a momentum that cannot be overcome. So, repeatedly, have I seen the modern systematizer enter the shop organization, upset the existing methods, put in his own pretty theories, only to find, upon returning six or nine months later, that the momentum of the old methods, devised by men who learned the shop's necessities through long and bitter experience, had been too much for his plans and that everything he had done had been, in some inexplicable manner, swallowed up and absorbed by the rolling old system. 'Tis only the theorizer, the man who has not "been through the mill" and who knows not the innermost recesses of the shop processes and cannot read the hidden thoughts and feelings of the members of a shop organization, who rashly promises to "put in a system that will revolutionize the shop and bring up its efficiency."

Rather study carefully the character of the work, the ability of the foremen and workmen, and the systems already in use, and then begin to adapt the new methods to the old—apparently deduce the new methods from the old—and you will have the intelligent support of the organization. And that support that will mean progression to newer fields of thought and activities, and not retrogression to the older methods.

These remarks, fundamental in their importance, apply with particular force to the determination of the wage system to be adopted. The principle of extra bonus for the attainment of standard time can be easily applied to almost any system of pay. Where it cannot be applied directly, the transition to a proper system is usually not difficult.

Systems of Pay.

The most prominent systems of pay in the United States are discussed below. In England there are many different plans, but these cited herein represent the most prominent in use today.

Day-Work Plan.—This plan, usually decidedly inefficient unless under special conditions, can be easily changed to a most efficient one by applying the bonus idea advanced by Mr. Gantt.

Premium Plan.—An efficient plan on many classes of work. The determination of standard times should, however, be made carefully. If the rates are determined by other methods the plan will eventually fail.

Piece Work.—By this the workman receives a certain amount of pay per piece. A very mischievous plan if it be accompanied by the continual cutting of rates. It cannot be considered efficient when the rates are established according to methods usually practised.

The Differential Plan.—Developed by Mr. F. W. Taylor, of Philadelphia; the piece price varies according to the rate of production. The greater the number of pieces turned out in a given time, the higher the piece price. This can be applied when the "intensity or rate of production" must be high in order to get the utmost out of very costly machinery, tools, etc.

The Bonus Plan.—Explained in detail by Mr. Gantt in his valuable paper read before the A. S. M. E. in December, 1901. Distinctly a system of task work combined with the use of instruction cards for the workmen and a bonus for accomplishing the task within the time set for it.

This bonus system of pay has always appealed to me as the most easily understood, the easiest to introduce with little opposition, and the most effective of all systems yet produced. It is adaptable in some form to almost any other system of pay that may be already in existence in the shop. It is the easiest to introduce in case the men are working upon the day-work basis. Nor is it difficult to persuade the workmen to abandon piece work for it in case the reward is made sufficient. I have been introducing it into works under my control with marked success.

It is of interest to note here, however, that even the closest analysis and study of the possibilities of assembling operations of great intricacy, such as the assembling of the counting mechanism of high-grade adding machine and cash registers, failed to give a positive indication of the possibilities of output in the case of a highly expert workman. The time of actual tests of the intricate assembling when made by the special tester fell far short of the time that could be easily maintained by the workman who, through years of repetitive processes, had gained marvelous skill. The study of his movements by a stop-watch expert would often show but little as regards the possibilities of increasing the speed of the essential operation, though expert observation will probably show that much can be gained by arranging the stock and tools properly and providing ample quantities of stock properly inspected for quality. But the skilled assembler can and will deceive anyone not of the highest order of expertness concerning his possible rate of production, particularly when he has worked for years in the assembling of small parts of great intricacy and where great accuracy is necessary. Therefore, I applied a simple plan of offering the men an additional bonus for every half-hour they gained, in the form of an increase (carefully proportioned according to the length of the job) to their half-hourly wage rate.

I am distinctly in favor of the bonus plan of pay when combined with methods that determine accurately the shortest time in which a job can be finished. It should include a bonus plan for the job bosses and the foremen by which they secure bonuses in case all the men under them earn bonuses. This will result in the foremen immediately giving their close attention to the inefficient workman for his proper and speedy training or his discharge.

Stock and Cost Keeping.

Much has already been written of stock and cost systems, the subject having been thoroughly covered by a number of able writers in this Magazine. I will not attempt to go into detail and describe any particular cost system, for that has already been well done. Besides, as already stated, each business presents its individual problems so that it is better to consider the adaptation of certain fundamental principles to existing conditions rather than to describe a fully developed system with the thought that it can be transplanted in its entirety to any other factory.

In fact, I shall not attempt within the confines of this article to discuss the theory of cost keeping, nor shall I deal with the problems of distribution of overhead or indirect charges. Rather shall I confine my attention to a description of a very simple and yet effective system of prime-cost keeping combined with the important stock-keeping and stock-tracing systems, which in actual practical use has proven of great value in a number of concerns when properly adapted to existing conditions.

To my mind a cost system should primarily be so devised as to give the manufacturer an accurate knowledge of his *most costly and expensive operations,* so that he may know unerringly these "high spots" and attack them vigorously. With this knowledge he can then devise various ways and methods of reducing costs. Without it he is well-nigh powerless. His stock system should enable him to keep down his investment to a minimum. His stock-tracing system should prove a most effective means of getting his stock through his factory rapidly and without delays. In other words, the practical value of these systems as thoroughly effective methods with which to locate the "inefficient spots," and through which to attack those operations or methods which are excessively costly, outweighs the importance of the theoretical securing of costs simply in order to determine the selling price. The cost system should provide a club with which to beat down costs—the stock-tracing system another club to drive the factory rapidly and economically. Therefore, the stock system, stock-tracing system, and cost systems are so interrelated as to make it impossible to consider one without the other.

Keeping of Raw Stock.—The stock-invoice card illustrated below will show clearly the nature of the data required to keep such records properly. The problems involved are,

1. The keeping on hand of sufficient raw stock.
2. The placing in the factory of proper amounts of stock for manufacturing purposes.
3. The keeping on hand of proper amounts of finished parts for assembling.

In cases where work is ordered wholly on special contracts, and special material ordered from outside manufacturers, the same simple system can be used with modifications and will prove of equal, if indeed not greater, importance; for in such cases some method by which special raw stock from outside manufacturers can be brought to the shop *on time* is absolutely necessary.

Necessarily the first form is the Requisition for Stock. This is so uniformly used as not to need illustration. It forms, however, a very important and necessary link to the chain.

The next important form is the Stock-Invoice Card. This can be placed at each stock bin or filed in the factory office.

STOCK INVOICE CARD Bin No.

Name and Specifications..

....

Am't Used per Mo...Order Limit..............................

Where Used...Rush Limit...............................

Date	Ordered	Received	Delivered to Factory	Order Number	Inventory	Check No.	

The most important point to note is the "order limit," or the limit at which new stock must be ordered. If it be raw stock then this limit must be determined by giving consideration to the amount of finished stock required in finished-stock bins, the length of time required to get the stock through the factory, and the length of time required to get the stock from the manufacturers. The "rush limit" indicates a dangerous condition of affairs that must be remedied by using extra efforts. In the case of raw stock the purchasing agent *must be notified immediately and kept after* continually.

In order to have this simple system work properly great care must be used in making all entries promptly and properly. It will be noted that this very simple plan provides a perpetual inventory of great value in many ways. While it does not provide for the combining of factory accounts with the general accounting, still it does provide a very simple, inexpensive, and in most cases a sufficiently accurate method of keeping accounts and values. Reports of raw stock reaching these limits must be made each night to the purchasing agent, a Special Rush List giving those that have reached the rush limit point.

In the case of the finished stock even greater care and vigor must be used. The entries having been properly made, a list giving the amount of those items of stock which have reached the order limit is sent to the stock tracer, who can ascertain whether additional stock should be ordered or stock already ordered hurried in its course of manufacture. A separate rush list showing the amounts of items of stock which have fallen to and below the rush limit should also be given to the stock tracer for his immediate and special attention. In many cases these lists should likewise be given to the departmental foremen, as they are thereby provided with the best possible means of knowing what work to rush.

The system as described is particularly fitted for that class of manufacturing in which the work is standard and many parts can be carried in stock.

In cases where the work is upon special contracts and the work not standard, careful consideration must be given to the time within which each department must do its share of work and turn it over to the next department, calculating of course from the given delivery date of the work. This time should be entered upon the Special Stock Tracing and Cost Sheet which will be illustrated later. (Page 940.)

All cost entries are made from the workman's time ticket. This ticket needs no description. It differs in each factory and each system of pay. It, of course, should contain:

1. Name of the department.
2. Name or number of the piece.
3. The order number and box number.
4. Character of the operation.
5. A full description of the amount of stock received and finished.
6. The price or rate, and total wage.
7. The time started and time finished.
8. Name of workman, foreman, and inspector.

STORAGE PLATFORMS.

Wherever possible it is advisable to establish storage platforms in each department. These should be of the height of the moving trucks so as to facilitate the loading and unloading. Each workman should have beside him only the job upon which he is working, and the next job upon which he is to start (with all necessary tools, gauges, clamps, fixtures, etc.). All other stock should be placed upon the platforms. The advantages are many:—

1. The foreman and the shop management are provided with a very close idea of each department's operating condition. An excess of stock shows an unbalanced shop condition. A shortage may prove a like condition in another department, and a too large capacity in the one under observation.

2. A foreman can thus easily apportion the work among his men so that no delays need be encountered. In addition to this he can easily collect the needed tools, gauges, fixtures, and clamps for the next job for each man—exceedingly important features.

3. Should the foreman note that he is running short of any particular stock adapted to any of his machines, he can notify the stock tracer who can easily afford him relief by rushing other departments. This prevents the foreman from running around the shop needlessly.

4. The stock-tracing or routing system is greatly simplified.

5. The taking of inventories is greatly simplified.

THE STOCK TRACING AND COST SHEETS.

All entries are made upon the Stock Tracing and Cost Sheets by the cost clerks. The rapidity with which these entries can be made by rapid clerks is remarkable. In one factory operating over four thousand men, all entries regarding immense quantities of stock were made upon these sheets by these clerks. A careful examination of this stock tracing and cost sheet shows that herein, in simple form, is contained a full history of each lot of stock in such form as to admit of many uses.

Opera-tion	Quan-tity	Depart-ment	Date Del'd	Should be Finished by	Date Re-turned	Time Consumed		Bonus Time		Actual Labor Cost	Work-man	Machine No.	No. Pieces Lost	Why	
						Hrs.	Min.	Hrs.	Min.						
Totals															

Order No.__________ Material { Weight__________ Cost__________

Name of Stock__________ Total Cost__________

Box No.__________ Date__________ Should be finished by__________

THE STOCK-TRACING AND COST SHEET.

1. The stock tracer, notified by his date sheets from the stock clerk of any stock which is running low, can quickly determine those departments in which is located that stock which may be further along in course of manufacture. He can readily force these foremen to produce the stock in time to prevent delays.

2. Delays in any department are clearly indicated.

3. The actual time consumed and the labor cost on each operation are closely indicated. There is provided an analysis that will prove of great value in the hands of one who will systematically hunt for the most costly points in production, with the object of devising tools or methods by which cost reductions can be made. The value of this record in inventories is apparent.

4. Each workman is clearly linked up with his operation. The columns showing "Loss" will provide an index to the efficient men.

5. The data relative to weight and value of raw stock may of course, be adapted to conditions. Whatever the plan pursued it may be very simple. We are thus easily provided with a prime-cost record of great value in devising cost reduction, and in the making of it we are provided with a full stock-tracing system.

As before stated, I shall not attempt to discuss the question of the overhead or indirect charge as this has already been dealt with fully, my object being solely to present a simple and adaptable system which will include the solution to all of the practical problems to be met with in manufacturing.

By using properly the data already upon the time ticket or stock tracing and cost sheet, supplementary reports of value can be made up such as:—

1. The individual workman's record, showing each man's record on each job.
2. The job record, showing the job time and cost record for each workman.
3. The departmental efficiency record, in which output, number of employees, pay roll, and costs are compared.
4. General factory output and efficiency record, showing comparison of output, hours work, pay rolls, and costs comparing one period (either months or years) with one another.

A factory thus equipped with a cost system that will enable the manufacturer to determine the proper point of high cost to attack, with a system of determining standard times, a method of stock location and tracing by which delays are avoided, the whole supported by modern organization and management, can defy competition.

EDITORIAL COMMENT

TWO correspondents have kindly called attention to a misprint in Mr. Mathot's article on the design of the modern gas engine, by which he appeared to limit the rim velocity of a band fly-wheel to 500 feet per minute. The correct figure, of course, is 5,000 feet. Mr. Mathot even admits 5,500 feet as not impracticable where the fly-wheel carries the belt, and 6,000 as a speed often reached in good practice when the fly-wheel runs light.

Out of the correspondence between our contributor and one of the correspondents just referred to has developed a commentary upon certain differences between Continental and American practice, so interesting that we are glad to reproduce it (with the consent of both parties) for the benefit of a wider circle of readers. We quote first from a letter of Mr. Randolph T. Ode, secretary of the Providence Engineering Works. Referring to the formula given on page 440 of our June issue, Mr. Ode says:

"I have used this formula for a great many years on steam-engine work, and was much pleased to notice that it was applied by Mr. Mathot to gas-engine work.

"We differ, however, with Mr. Mathot as to some of the constants he recommends for use in gas-engine work, as we do not think they are consistent. For example, the constant that he uses for Otto-cycle engines, single-acting, single-cylinder, of 44,000, is nearly six and one-half times that which would be used for a double-cylinder tandem double-acting engine. However, that is a matter of opinion.

"Another question we would like to have answered: In a preceding part of his article, Mr. Mathot refers to a difference in governing between the hit-and-miss method of operating a gas engine and the throttling method of operating, but he does not give us information as to which system these fly-wheel constants, etc., in his formula apply to, leaving another source of confusion in the reader's mind.

"Then, too, I would differ also in the constants that Mr. Mathot uses for ordinary electric lighting by continuous current, etc., as compared with direct currents and the like and alternating-current generators in parallel. That again, however, may be a matter of experience; but our experience, which extends over many years in high-grade steam-engine construction, does not warrant the tremendous differences, which amount to 1 to 6 as exemplified as gas-engine constants.

"Mr. Mathot also states on page 431 of his article (THE ENGINEERING MAGAZINE, June, 1907): 'So far as general practice is concerned, it must be realized that there is no reason whatever why the substitution of an explosive mixture for steam should cause any material difference in prime movers'; and after making this remark he makes no statement whatever as to the merits of the overhung double-crank system, according to European practice, as compared with single side-crank construction which is being adopted by a majority of the American builders. This is an exceedingly important point, and one which I know very well has been brought to Mr. Mathot's attention very often before this.

"If you can kindly do so, to make his article more complete, we would like to secure his opinion."

Mr. Mathot's reply to the queries was cordial and comprehensive, and from it we make the following abstract:

"No slip has occurred in giving the constants to be used for the calculation of fly-wheels, and the constants K suggested are determined by both theoretical computation and practical experience. Whatever the difference may seem to be between the constant for the single-cylinder single-acting engine and that for the tandem-cylinder double-acting, the figures are right.

"Of course, the constants refer to improved systems of governing; for I consider that the 'hit-and-miss' method, while it gives very good results on small engines, should not be applied to engines of more than 25 horse power. Further, I do not think there is any valuable example of the application of the hit-and-miss to large engines of the double-acting tandem or double-acting twinned tandem types.

"Regarding the permissible grade of irregularity—or amount of variation during a single revolution—the figures I have given agree with the best technical practice and are those used by the leading experts on the Continent. Of course, these figures cannot be compared with steam-engine practice. I should cite the statements of authorities from which it would appear that to reach the same regularity with a four-cycle single-acting gas engine as with a single-cylinder steam engine, the fly-wheel must be 9.3 times as heavy, or must have a rim velocity 3.05 times as great ($\sqrt{9.3} = 3.05$).

"The statement quoted by Mr. Ode—that 'there is no reason why the substitution of an explosive mixture for steam should cause any material difference in prime movers'—is to be qualified by the clause limiting this to structural features. This, of course, relates to the steadiness of the frames, the mode of fastening them to the foundations, the provisions for inequality of expansion, etc., but not to regularity of running.

"Concerning the question of single *versus* double crank, in which young American practice seems to be quite different from the older European practice, I have already set forth that the determination whether the side crank is better than the center crank or *vice versa* is to be solved by future experience. I should observe, however, that so far as my own knowledge goes, the adoption of the side crank is limited to the Allis-Chalmers, the Power & Mining Machinery, and the Westinghouse companies, whilst in Europe the engines made on the double-crank system now aggregate about 450,000 horse power. The first large engine for blast-furnace gas, one of 200 horse power, was built by those pioneers in large gas-engine work, the Cockerill company, on the side-crank system; but since then no further attempt has been made in that line. In any case, there is no doubt that the use of the side crank necessitates much larger shafts and much heavier bed frames than that of the centre crank maintained between two bearings, without any overhang.

"It is perhaps true that the single crank better meets the conditions of American practice, because of the difficulty of getting highly skilled mechanics and fitters for the erection of these large engines. This trouble is overcome by the simplicity attending the accurate fitting in line of two bearings instead of the three which are necessary when the bed frame has two bearings, one on each side of the fly-wheel, and a third bearing is provided at the other side."

Mr. Mathot expresses his very active willingness to answer any further questions, but the points already elaborated will doubtless be welcome to many readers, whose thanks will be offered to both our correspondents for the discussion. It is Mr. Mathot's strong conviction that gas-engine work has too often started *de novo*, with too little interchange of study and data among the various investigators, and too little use of the fund of experience accumulated both in theoretical investigation and practical use of the steam engine. This pleasant sequence to his series of articles suggests the profit attending a frank comparison of views between independent expert authorities, especially when this interchange of opinion can be given that international range which it is the happy province of THE ENGINEERING MAGAZINE to facilitate.

* * *

WE have referred in these pages, with a frequency which may seem like persistence, to the possibility and the need of some readjustment of our higher courses of technical education which shall bring and keep them closer to the industrial requirements of the times. The school of applied science, at its inception, was first of all an institution to provide men soundly trained in the new and rapidly enlarging field of occupation provided by the expansion of engineering and its allied professions; but secondly, it was a revolution on educational ideals—a secession from the ultra-classical forms into which the older university courses had crystallized. It was an assertion that mental culture could be made liberal and at the same time useful. But—following a tendency which has always characterized all forms of dissent—it shows some signs of itself becoming over-formalized or over-classicized. The opinion is too often expressed that the young technical graduate is too solicitous for technical ideals and unfamiliar with economical limitations; that, as Mr. W. M. McFarland has so aptly put it, he is so indoctrinated with the saying, "The best is good enough," that he does not give large enough place to the often necessary antithesis, "Good enough is the best." Another interesting commentator phrased it more radically: "We could do with less calculus and thermodynamics, but would like more sound, practical industrial economy."

Perhaps the most striking instance of the lack of exact parallel between the engineering schools and the modern developments of engineering occupation is the lack of any adequate provision for the student whose life work is to be the superintendence of a manufacturing plant. There, at least, more room should be made than any of the schools has yet afforded for instruction in factory conditions, the influences which affect the economy of production, methods of organization and operation, wage systems, the supervision of work and of material, and the analysis of costs with a view to cost reduction. A beginning is being made by some of the most advanced colleges, but in our opinion the full possibilities will not be realized—either in this course itself or in its helpful influence in making other engineering courses more practical—until the subject of "works management" is given a standing and a proportion equal to that afforded to stationary, marine, or locomotive engineering.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE QUALITY OF STEEL RAILS.

SUGGESTED IMPROVEMENTS IN THE PROCESSES OF MANUFACTURE OF BESSEMER STEEL RAILS.

Henry M. Howe—The Engineering and Mining Journal.

ONE of the most important metallurgical problems of the day is the improvement of the quality of steel rails. In the early history of railroading bessemer-steel rails, relatively low in carbon and high in phosphorus, were able to give satisfactory service under the existing conditions of manufacture and traffic. The conditions of service have, however, changed much more rapidly than metallurgical practice has advanced, and higher speeds and heavier trains have demanded qualities in rail material which the bessemer process has not been able to supply. At the present time attention is being drawn to the problem more strongly than ever before on account of the frequent breakages of rails in service and the numerous derailments due to this cause. This element of danger in railway operation has no doubt been greatly exaggerated by popular clamor, but it is nevertheless very real, and it is to be hoped that earnest co-operation of manufacturers and railroad men will result in a speedy and satisfactory solution of this problem. In a recent number of *The Engineering and Mining Journal,* Prof. Henry M. Howe of Columbia University gives an interesting review of possible improvements in processes of manufacture, from which the following extracts are taken.

With light wheel loads a 70-pound rail with 0.10 per cent. phosphorus and 0.35 per cent. carbon gave satisfactory service, but the rapid increase in wheel loads soon necessitated the reduction of abrasion by the use of a harder rail material, that is, one higher in carbon. The increase in the carbon content of steel had a great effect in intensifying the embrittling influence of the phosphorus and the brittleness of the steel was further increased by a variation in the process of manufacture which materially raised the temperature at which the rolling of rails is completed. Hence, to make rails safe for present conditions of traffic this brittleness must be lessened by reducing the phosphorus content of steel and lowering the finishing temperature. Sufficient low-phosphorus ores are not available to supply the great demand for steel rails and a dephosphorizing process must be resorted to. The basic open-hearth process removes practically all phosphorus but it would be impossible to discard the bessemer process for a great many years at least. In the meantime means must be found to improve the bessemer process and remove the defects which cause the brittleness of the steel product. The bad effects of phosphorus can be greatly reduced by restraining segregation.

"In order to lessen the degree of what we may call residual segregation, the segregation which remains in the finished rail, I advise three steps: first, free use of aluminum; second, extremely slow pouring, and third, greater discard from the top of the ingot.

"The use of aluminum will lessen segregation materially, but it will lengthen the pipe; or where no pipe exists it will increase the tendency to piping. This tendency in turn will have to be met by cropping off and discarding a larger part of the top of the ingot."

Extremely slow pouring will counteract the pipe-lengthening effect of the aluminum in that it should both shorten the pipe and raise the segregate toward the top of the ingot. The pouring should be as slow as possible without allowing the whole heat to cool so much as to form a ladle skull. Means of increasing the practicable slowness of pouring would be to cast two or more ingots simultaneously, either through separate nozzles from a single ladle or by means of a distributing funnel, or to keep the steel in the ladle artificially heated by burning oil or gas on top of it.

"The richest of the segregate lies near the top of the ingot, usually in the upper 20 per cent., often in the upper 10 per cent., of its length. There is good reason to hope that, by means of slow pouring, it can always be kept in the upper 10 per cent., even if aluminum is used freely. To increase the discard of course is to increase the cost of a ton of finished rails, and to lessen the output of finished rails. However much this may be regretted, it may prove to be a necessity. It is idle to crop off only the mechanically unsound top part of the ingot, and leave just below the most dangerous, because the most segregated part, the part in which the phosphorus from the whole ingot is concentrated.

"The degree to which the cost would be increased and the output would be lessened by increasing the discard, has been overestimated by many hasty writers. They have assumed that a discard of say 20 per cent. would decrease the output by 20 per cent., forgetting that there is already a very considerable discard, and that it would be only the excess of the proposed discard over the present that would decrease the output.

"It is well known that within certain limits the higher the temperature at which the rolling of the rail ends, the more brittle will the rail be; and that the power of the rail to endure shock is increased by continuing the rolling process until the temperature has sunk to a point at which the metal itself has become so hard that further reduction by rolling becomes extremely difficult. The trouble in applying this principle has been that, while it is easy enough to arrange matters so that the rolling of the thin web and flange of the rail shall continue till these parts are properly cool, yet, because the head of the rail is so much thicker than the web and the flange, and because it therefore cools so much more slowly than they, it still remains very hot at a time when they have already grown so cool and hard that it is not practicable to reduce them farther by rolling. On this account the rolling ceases while the head is still far too hot, and through this the metal in the head is seriously injured.

"But this condition of things, though convenient enough as far as the mere administrative work of rail making is concerned, is not necessary, if indeed it is intelligent, Today we may question whether it is tolerable. If, as I understand, it is to the interest of the railroads that their rails shall have the greatest attainable power of resisting shock, some method of lowering the finishing temperature of the rail head should be sought. What that method shall be it is for rail-making experts to decide. That some practicable method can be found we can hardly doubt.

"To bring this about by some change in the procedure in rolling may be possible, but the difficulties are certainly very great. The usefulness of the Kennedy-Morrison process of setting the rail aside to cool for a short time just before the last pass, has been challenged on the ground that the reduction which the final pass gives is too slight to improve the condition of the rail-head materially. This in turn probably rests on the further fact that, when the rail has grown as cool and rigid as it is at this last pass, it is not practicable to reduce one part, say the head, materially more than any other part, say the flange; because if we did, the greater reduction of the cross-section of the head would elongate the head in the direction of rolling, or parallel with the length of the rail, so much more than the flange, as to camber the rail very seriously. Such unequal reduction by means of what is called an 'unbalanced pass' can be resorted to earlier in the rolling operation, when the metal is so soft that the camber thus caused is immediately effaced by the collars of the rolls, or by suitable pieces attached for that purpose; but at the end of the rolling, when the metal has grown rigid, this effacing of a serious camber is impracticable. Hence, after the rail has been set aside for cooling in the Kennedy-Morrison process, all the reduction that can then be given to the head is the slight one which can simultaneously be put upon the rigid web and flange, a reduction so slight that it does not remove the injury caused to the head by its exposure to the high temperature.

"Like considerations stand in the way of another plan which naturally suggests itself. That plan is to adjust the passes in such a way that the flange and web shall reach their final size, or come very near to it, at a time when the head is still much larger than its final size; and then in the subsequent passes give only very slight reduction to the relatively rigid web and flange, but heavy reduction to the head, which would thus meanwhile be cooling continuously.

"But here, as before, the difficulty arises, that reducing the head materially more than the flange in these proposed last passes, would cause a camber so strong that to remove it would be difficult if not impossible.

"Another and an expensive way would be to change the section of the rail in the direction of making the web and flange much more nearly of the same thickness as the head. The present design is based on civil engineering rather than on metallurgical considerations. The web, because it is so near the neutral axis, does not, from a purely civil-engineering standpoint, need to be very thick. The flange, made very broad so as to prevent the rail from being overturned by side pressure, and also so as to prevent its cutting into the tie, does not need great thickness from a purely civil-engineering standpoint. But the head has to be made thick, in order to endure the concentrated wheel load applied to its upper surface. Manifestly, the head cannot be wide and thin like the flange; it must be thick and relatively narrow. . . . . But there is no reason beyond that of expense why the web and flange should not be heavier; indeed why they should not be approximately as thick as the head. If they were, then the cooling of the web and flange would not thus outrun that of the head, and the rolling of the whole could continue until not only the web and flange, but also the head, had cooled off to a proper finishing temperature."

Prof. Howe considers that the drying of the blast, which is often advocated as a means of improving the bessemer product, would have little or no effect. Variations in the temperature of the converting operation are caused by so great a number of circumstances that it is not likely that the removal of variations of the amount of moisture in the air would lead to much improvement, particularly as this is by no means the greatest of the causes contributing to variations in the rapidity of the blast. Finally but little assistance is to be derived from electrical purifying processes for removing phosphorus as at the present stage of their development they are so expensive as to be absolutely unavailable.

THE ENFORCEMENT OF SPECIFICATIONS.

A DISCUSSION OF THE PRECAUTIONS WHICH MUST BE OBSERVED TO SECURE THE DELIVERY OF SATISFACTORY MATERIALS.

Dr. Charles B. Dudley—American Society for Testing Materials.

THE development of specifications has been one of the most important and far-reaching results of the advance of knowledge of the properties and strengths of materials and of methods of testing. When first used, the specification amounted to nothing more than an attempt on the part of the purchaser to give the producer an idea of his needs. Later it became a demand, often couched in such terms as to antagonize the manufacturer. In its present development it amounts to an agreement, of which both producer and consumer approve and from which both expect to derive benefit. Being of the nature of a compromise in which differences are harmonized and conditions arranged to the satisfaction of both parties, it would seem an unnecessary waste on the part of the purchaser to take elaborate precautions to secure the enforcement of the contract, provided that the manufacturer is accounted a man of honesty and integrity in his business relations. That such precautions are necessary, however, was interestingly pointed out by Dr. Charles B. Dudley in his presidential address before the recent annual meeting of the American Society for Testing Materials.

"There are so many conditions leading to the manufacture and delivery of unsatisfactory materials, that is, materials that do not fill the requirements of the specification on which they were bought, which conditions do not involve the business integrity, or the honest intention on the part of the producer to do as he has agreed, that we are sure no one need feel aggrieved at the establishment and maintenance by consumers of devices for the enforcement of their specifications. No one believes more devoutly than we do, that with few exceptions, that are so few as to be almost ignorable, producers in general prefer to do an honest business at a fair price and profit, and that they always would do so, if—it were not for certain conditions. What, then, are some of these conditions?

"The first condition which leads to the tender of unsatisfactory materials is, improperly worded or unreasonable specifications. It is obvious that the viewpoint of those having to do with either the making or carrying out of specifications being different, and in a sense antagonistic, since their interests are naturally and legitimately opposed, the meaning which they attach to words will be different, and both parties may be equally honest. In like manner an unreasonable requirement in a specification, may lead to the same result. Our friends, the steel manufacturers, are constantly being presented with specifications containing stipulations which it is impossible or at best, only occasionally possible to fill. Those who have made these specifications have, we fear, neglected one of the prime requisites of a good specification, viz.: to consult with, and on certain technical points, be guided by the best manufacturers."

The mistakes of subordinates are a frequent cause of the delivery of unsatisfactory materials. Sometimes these are mistakes pure and simple; at other times they arise from an excess of zeal on the part of the subordinate who will include inferior material in a shipment under the impression that he is doing his employers a service. It must also be remembered that commercial processes do not always yield what is expected of them notwithstanding every effort on the part of the producer to secure a satisfactory result.

"A contract taken at too low a figure is a fertile cause of unsatisfactory materials. Under stress of competition agreements are made that if carried out strictly in accordance with the specifications, would result in loss, or lack of reasonable profit. Again, strange as it may seem, a very large number of manufacturers of commercial products, as a matter of fact do not know the characteristics of their output. They have been making and selling their staple for a period of years, it may be, and as long as the consumers accepted the material, and raised no questions, they themselves saw no need of making tests and experiments, except perchance such as would lead to diminution of cost in manufacture. Accordingly very little or no knowledge was obtained of those qualities of the material which are of most interest to the consumer. And yet, without that knowledge, contracts are taken and shipments made. Again the tender of unsatisfactory material is often explained after it has been tested and found wanting by the statement that although it may not quite fill the requirements, it still is good material and will do the work. Of course it takes but a moment's reflection to lead any fair minded person to the conclusion, that this statement is not at all the question at issue, and that if the consumer had been willing to use a material that is, in the language of the shops, 'just as good,' he would have specified such material, and obtained the benefit of a corresponding variation in price."

A sudden shortage in the raw-material supply often leads a manufacturer to substitute inferior material for that specified on the ground that delay would otherwise be caused. Such an argument should, of course, never prevent the rejection of the unsatisfactory material, and the same may be said of the argument often advanced by tenderers of inferior materials that delay will be caused if these materials are not received and used. In the first case, a frank statement of the conditions by the manufacturer would generally result in an extension of the time of delivery and remove the difficulty; for the latter there is no excuse and no remedy.

"If we have succeeded in what has been said, it is evident that there is necessity for the enforcement of specifications, and that, too, without assuming that men are dishonest or do not intend to do as they have agreed. Under present commercial conditions, and with our present knowledge of the properties of materials and of the processes by which they are made, it simply would not do for the consumer to leave his interests wholly in the hands of the producer. Each must look out for his own interests, and be prepared to defend and maintain them. Perhaps we have said more than is necessary on this point, but the practice of buying and using materials on the reputation of the maker is so deep-seated and widespread, and has for so many years been the refuge of engineers in cases of failure, that perhaps the subject will safely bear elucidation at a little greater length than would otherwise have been admissible.

"But how shall specifications be enforced? What are the essentials of successful enforcement? We reply, first, the examination and testing of the material tendered must be so planned as to be efficient and leave no loopholes for evasion or substitution of inferior materials. In the case of some substances, every shipment must be tested. In the case of others, as for example, materials that are produced in heats, or are stored in tanks or bins, the tests deciding their fate may be construed to cover the whole amount even though there may be a number of deliveries. The essential feature is that each test or lot of tests shall cover a definite amount of material, and that nothing shall be left to the honesty and good intention of the producer or shipper. If we are going to trust the producer in one detail we may as well trust him in all. The strength of a chain is the strength of its weakest link. No universal rule can be given, but assuming that the specifications are wisely drawn and provide only essential tests, these tests must be so applied as reasonably to cover all the material that is delivered."

Dr. Dudley points out the following essentials of effective sampling. In the first place, a representative of the consumer must always take the sample because, as has been already explained, it is neither reasonable nor safe to trust the producers in anything by which the validity of the tests might be affected. A second point, which is almost always covered by the specifications, is that the sample must be representative of the whole shipment or lot under test and should also represent a definite amount of material. The sample should be taken at random and not always from the same place. Familiarity with the methods of an inspector opens the way to imposition and fraud, particularly in those establishments where the subordinates are paid according to the amount of successful output and are thus liable to make "unintentional mistakes." Finally, sampled material should not remain in the hands of producers unless absolutely necessary. If it cannot be removed at once it must always be marked in such a way that substitution would be impossible. The chances for "unintentional mistakes" are too numerous and such mistakes too common to permit of any uncertainty on this point.

"Let us assume that the specification has been wisely drawn, that a shipment has been properly sampled, and that the tests show that it does not fill the requirements. What is the next step? As a matter of fact in our own daily work, but one thing is ever done, and that is, the material is rejected. None of our specifications provide for a second or third sampling and corresponding tests. Our theory is that the material ought all to be of the grade called for by the specifications, since this is what the consumer has bargained for, and if this is the actual fact, one sample is as good as fifty. We are quite well aware that there are many specifications in force, which provide for second, and if need be, third tests, the fate of the shipment to be decided by the majority. But this has for a long time seemed to us to be a survival of the crude early days of testing, when neither producer nor consumer knew much about materials, and which it is high time should be banished forever. If a specification is so severe that only two-thirds of well made material will stand test, the specification should be changed, and if a manufacturer can only make a product two-thirds of which will stand test, he should either learn how to improve his product or go out of business. Testing was never intended to be a device to bring about the acceptance of inferior material; but quite the contrary. Moreover, from three samplings and tests, it is but a step to five or seven or nine, and perhaps if sampling and test is long enough indulged in, a majority may ultimately be found which will always bring acceptance of the material. Surely the interests and responsibilities of the consumer cannot be trifled with in this manner.

"This whole matter of multiple tests, retests, and the disposal of unsatisfactory material can, as it seems to us, be summed up in a few words. Multiple tests are pernicious and should be abandoned. Retests, including the sampling, should never be made unless there is reasonable evidence to think there is an error somewhere in the first test, and to decide this point every reasonable facility should be furnished by the consumer to the producer, to enable him to satisfy himself. Shipments of material once fairly rejected should never be accepted and used if the material is of such a kind that safety or risk to human life is involved, and finally, it is suicidal, and brings with it a train of almost unmanageable subsequent conditions, to accept rejected material in which only commercial considerations are involved, unless there is some abatement in price."

THE FACTOR OF SAFETY IN STRUCTURES.

A DISCUSSION OF THE IMPORTANCE OF WORKING STRESSES AND FACTORS OF SAFETY IN STRUCTURAL DESIGN.

A. N. Talbot—Bulletin of the Engineering Experiment Station, University of Illinois.

THE term "factor of safety" was apparently invented by the pioneers of modern constructive engineering in an endeavor to remove the popular idea that metal construction could never be made as safe as wood or stone. Since those early days, experience and research have continually added to our knowledge of applied mechanics and strength of materials, but the use of factors of safety has, in general, lost but little of its vagueness and is even now governed by precedent and convention rather than by an exact conception of their functions. It has been remarked repeatedly that the study of the "unutilized material" in structures is of fully as great importance, as regards both strength and economy, as that of the utilized portion, but engineering research has confined itself almost exclusively to determinations of strengths, capacities, etc., and has left the principles on which correct factors of safety for various materials and types of construction may be determined almost uninvestigated. In his recent report on Tests of Concrete and Reinforced-Concrete Columns, forming Bulletin No. 10 of the Engineering Experiment Station of the University of Illinois, Prof. A. N. Talbot makes the following comments on the importance of the factor of safety in structural design, with particular reference to concrete structures.

"The real basis for a working stress or a factor of safety to be used in designing seems not to be generally understood, or at least it is not often properly explained, and expressions sometimes heard indicate that the purpose and use of factor of safety and working stress are misinterpreted. Of course, no engineer will say that for a factor of safety of, say, four (using the term factor of safety as based upon the ultimate strength of the material) the structure will take four times the assumed load without injury. It is understood by engineers that the actual ratio of the load which the structure may properly take under the ordinary conditions of construction to the assumed load used in the calculations made in the design is not large and may, under some circumstances not be very much above one. Yet the statement is sometimes made, or the inference may be drawn, that because a given working stress is to be used in the calculations there is no advantage in looking into the behavior of the material or the action of the structure at a stress higher than the assumed working stress. It may, therefore, be well to consider some of the aspects of working stresses and factors of safety.

"Mild steel has a rather definite elastic limit and yield point beyond which the character of its action changes in a marked way. Beyond the yield point the rate of stretch in tension becomes almost at once one hundred or more times as much as it was within the elastic limit. In compression, the ultimate strength of mild steel is not far beyond its elastic limit. It is evident that a structure made up of this material will distort and fail when a load producing stresses not much greater than the elastic limit is placed upon it. The elastic limit of mild steel has a small range, its value running from 50 per cent. to 65 per cent. of the ultimate strength, depending upon the size of the piece, method of rolling, etc., and the steel is made under such conditions that little risk is taken in choosing a value for a particular size and shape of piece. The modulus of elasticity of steel is also quite uniform. It may be said then, that the properties of this material, with proper inspection, are fairly definitely known. When we base the factor of safety of a structure upon ultimate strength of mild steel, whether we do it consciously or unconsciously we have tacitly assumed that the factor of safety named in the calculations is nearly double the factor which will bring actual failure under the conditions assumed to exist in the structure.

"For a plastic material, or a material not having a definite elastic limit, or at any rate one for which the stress varies directly as the deformation for at best only a small part of the ultimate strength of the material, a different consideration must be given. For such materials, the effect of lack of uniformity of the material, the effect of increased deformation, of repetitive loading, of time, and of other factors must be considered.

"But there are other considerations which go to confine the working stress, particularly in concrete, to the low value usually assumed. Sometimes the stress is made low to allow for a possibly greater load than that assumed, or for a load applied other than statically. Even if the assumed load has the correct total amount, the following items may be said to influence the choice of a lower working stress: (1) Uneven distribution of load among members; (2) Unconsidered stresses due to settling, variability of the material, etc.; and (3) Variation in the material and in its farbrication.

"(1) Even with a load of the amount assumed, the division of this load among the members of the structure may be uneven. Variations in stiffness, differences in quality of adjacent members due to inherent variations or to the variations which arise in such a material as concrete during fabrication and setting, differences due to restraint or lack of restraint at connections—all go to make the actual distribution of the load different from its assumed division among the members. In a timber trestle bridge, the weaker stringer is generally less stiff than its stronger neighbor, and hence the poor stringer takes a smaller share of the load and the good one a greater. Even in steel building construction, differences in rigidity of connections, modifications made to overcome lack of exact fit, and variations caused by field riveting act to modify the division of the load. In concrete construction the variations in fabrications and conditions of setting (*e.g.*, in the beams and girders) and the consequent variable effect on stiffness and restraint may have a considerable effect upon the division of the load. This is especially true in the floor, beams, and girders, so that the load transmitted to a particular column may be quite different from that assumed.

"(2) Settling of the foundation of one column more than of another is possible. A variation in the shrinkage of adjacent columns through variation in conditions attending fabrication or to a less extent in porosity or stiffness of column will modify the distribution of the load. Variations in size also affect this distribution. The more nearly uniform the dimensions and physical properties, the more nearly regular the division of load will be and the higher the allowable comparative working stress. In this respect, steel is an advantageous building material.

"(3) The values of physical properties usually quoted are average values. The data were obtained from test pieces, sometimes large, frequently small, and these may be said to have been made and tested under favorable conditions. Since the members of a structure which have the poorest quality may have a controlling influence upon the amount of load to be carried, if average values are used the factor must be greater to allow for this. In other words, in poorly made beams or columns the load or stress which comes on the piece is relatively nearer the point of failure than is indicated by the use of the assumed working stress and an average ultimate value.

"Enough has been said to show that the assumed stresses are not the actual stresses coming upon the members of a structure and that the relation between the assumed working stress and the average ultimate strength of the material is a matter which should involve thought and study. It may then be stated that (a) the stress actually brought upon a member of a structure by an assumed loading may be materially higher than the assumed working stress, and (b) the stress actually developed in a member may be much higher comparatively (*i. e.*, with respect to its own ultimate strength) than even this increased amount would indicate. This goes to show that the nature of the action of the material, including its stress-deformation relation, should be studied at points well above the assumed working stress. What point should be fixed upon as a basic point, upon which a working factor covering uneven distribution of load, uncertainty of quality, effect of repetitive loading, etc., may be based, will depend upon the nature of the material and the condition of the structure."

THE DURABILITY OF REINFORCED-CONCRETE STRUCTURES.

THE CONDITIONS LIKELY TO AFFECT THE DURABILITY OF REINFORCED-CONCRETE CONSTRUCTION AND THE PRECAUTIONS WHICH ARE NECESSARY.

F. E. Wentworth-Shields—Institution of Civil Engineers.

A PAPER presented at the recent Engineering Conference of the Institution of Civil Engineers forms an interesting supplement to Mr. Collins' remarks on reinforced-concrete as a construction material on another page of this issue of THE ENGINEERING MAGAZINE. The paper, of which the following is a full abstract, deals with the conditions likely to affect the durability of reinforced-concrete structures and the precautions which should be observed in designing:

"Probably one of the principal reasons why English engineers have hitherto hesitated to introduce reinforced or steel concrete is that it is difficult to speak with certainty about its durability. Only fifty years have elapsed since Monier first used it, and only about ten years since it was employed on any scale in this country; so that it is not yet possible to point to any work in steel concrete which has stood the test of centuries, and all we can do is to look at existing structures, and notice carefully how far they have suffered, and what repairs have been necessary. In so doing we can not only form an idea whether steel concrete is likely to be long lived, but also what precautions are necessary when designing in order to render it so. The chief things which we should expect to shorten the life of reinforced concrete are:—

1. Settlement of foundations.
2. Fire and earthquake.
3. Atmospheric change (rust, etc.).
4. Abrasion and collision.

"1. Dealing first with settlement of foundations, it may be said that steel concrete is a rigid material, and the foundations of a structure of this substance ought to be designed in such a way that they cannot settle. This can always be done even on soft ground, either by piling or by spreading the weight over a large area, on a strong reinforced-concrete base. An instance of the evil of neglecting this precaution was to be seen at the Kom Ombo pumping station in Upper Egypt last year. A culvert of reinforced concrete 10 feet in diameter was laid in the Nile silt. The ground had evidently been disturbed beneath it, and the culvert settled down, producing transverse cracks in the concrete. The water escaping from these cracks no doubt aggravated the settlement, and by the time the culvert came to rest the leakage of water was so serious as to necessitate its being abandoned.

"2. Reinforced concrete is undoubtedly a first-rate fire-resisting material. Many experiments have been made to test this, but perhaps one of the most striking proofs is the fire which occurred a few years ago in a warehouse in Baltimore. Not only were the contents of the building destroyed, but its brick walls almost entirely collapsed; the floors, however, which were of concrete reinforced on the Hennebique system, and supported on steel concrete columns, remained intact. It would seem that for fire-resisting purposes it is best that the steel should consist of many bars of small section in preference to few bars of large section, as the first arrangement forms close net-work, which prevents pieces of concrete from dropping out and so reducing the strength of the building. It is also important the concrete aggregate should be crushed small. The ideal composition for the aggregate would seem to be a strong flint or granite for the hearting, with an outside skin of cinder concrete to act as a good non-conductor. It is essential that in a building, the walls, floors, and posts should be well tied into one another.

"There is a tendency nowadays, in designing steel-concrete buildings, to reject that material for the walls on the score of expense, using it only for floors and columns. Sometimes a compromise is made; for instance, at the tobacco warehouse now being built at Bristol on the Coignet system, the walls consist of a framework of steel concrete with brick panels. This is probably the best arrangement, as, although brickwork is undoubtedly more economical for walls than steel concrete, still the latter is much less inclined to collapse under fire. The brickwork can be arranged, as at Bristol, to conceal the concrete entirely, but the collapse of any part of the brickwork would not endanger the floors or the concrete framework.'

"With reference to damage by earthquake, reinforced concrete was subjected to an excellent test in the San Francisco earthquake. The museum building at the Leland Stanford University had three wings, one of reinforced concrete and two of brickwork. The building received a very severe shaking, and while the brick wings were in a state of collapse, the damage to the steel-concrete wing was insignificant.

"3. We have had enough experience of concrete to know that, if good, it is practically unaffected by atmospheric changes. At one time it was feared that the steel might rust, especially in structures under water, but this fear seems to be groundless. Some recent experiments on the permeability of concrete by Mr. Baldwin Wiseman show that, if well made, it is one of the most water-tight materials known, and that it rapidly becomes less and less porous when water is forced through it. Moreover, some experiments quoted by Mr. Marsh in his work on "Reinforced Concrete" seem to show that cement has some chemical action on iron which prevents rust. At all events, a recent examination of three steel-concrete quays at Southampton standing in water convinced me that there was nothing to fear on this score, provided, of course, that the concrete is not accidentally knocked off, and that it is of good quality.

"Some experiments recently communicated to the American Institute of Electrical Engineers raised the alarm that steel rods immersed in damp concrete rust rapidly when mild electric currents are passed through them. To this the best answer is that well-made concrete should not be, and generally is not, damp. It will have been noticed by those who have had to cut out good steel-concrete work that, although recently immersed in water, the concrete and steel were both dry and clean, and that the water appeared unable to penetrate even the inch or two of concrete which covered the steel. However, the risk should not be overlooked, and care should be taken to exclude electric currents from steel-concrete work as much as possible.

"4. It has been stated that steel concrete has far more resistance to abrasion from shipping or other floating objects than timber, but my experience at Southampton convinces me that this is quite exaggerated praise. On the contrary, if reinforced concrete is to be used for marine work, it must be carefully fendered at all parts where it is likely to be struck. In most systems of reinforced concrete the steel is placed within an inch or two of the surface, and if the structure is not protected by timber cushions, this concrete skin is easily knocked away, leaving the steel naked and liable to rust. At the same time it is true that steel concrete does not spall easily from blows, provided they do not fall directly on the concrete; and it will stand a wonderful amount of shocks, and bending due to shocks, if a wooden fender is interposed.

"The coaling-jetty at Southampton (completed 2½ years ago) suffers as much, perhaps, from the blows of ships and barges as any steel-concrete structure yet made. It is protected by fenders of American elm, and in spite of blows which have caused the whole jetty to sway, there is no sign as yet of the concrete spalling off, except at one or two places where the blow has fallen directly on the concrete.

"Speaking of this jetty calls to mind an interesting piece of repair-work which was carried out there about two years ago. A steamer collided with the quay, breaking two piles and the beams they supported. On examination by divers it was found that the piles were broken down to a level of 12 feet below low water. The work of repairing the quay, however, turned out to be fairly simple; the broken concrete and steel rods were cut away by divers, who also erected new rods to take their place. These new rods were joined to the undamaged part of the old ones by steel tubes, and the stirrups or binding-wire were placed round the new rods at correct intervals. A watertight casing of timber was then placed round the pile, which extended from the undamaged portion to above low water. From this casing the water was pumped out, and the concrete was filled and rammed into the box in the ordinary way. Above low water the piles and beams were remoulded in just the same way as they had been originally built. This shows how easily and effectively steel concrete can be repaired.

"On the whole, it may be said that our experience goes to prove that reinforced concrete, if well designed, is likely to be one of the most durable building materials, if not the most durable, that can be found."

ENGINEERING SCHOOLS AND POLYTECHNIC EDUCATION.

A DISCUSSION OF THE DUTY OF ENGINEERING SCHOOLS IN PROVIDING INSTRUCTION FOR FOREMEN AND SUB-SUPERINTENDENTS.

Dugald C. Jackson—Society for the Promotion of Engineering Education.

THE scarcity of skilled workmen, and particularly of artisans fitted for the lower positions of responsibility and superintendence in manufacturing establishments, is generally admitted to be one of the most pressing problems in industrial operation of the time. The revival of the apprenticeship system on an extended scale by several of the larger concerns will, no doubt, solve the problem in these few individual cases; but the manual-training schools and trade schools, on which the bulk of the manufacturing industry of the country must depend for the technical training of foremen and operatives, are utterly inadequate in numbers, equipment and instruction to supply the ever-increasing demands of industry. Dugald C. Jackson of the Massachusetts Institute of Technology, in his presidential address before the recent annual meeting of the Society for the Promotion of Engineering Education, considers that the supplying of the "corporals and sergeants" of industry is a function of the engineering schools no less important than the training of professional engineers, and he lays the blame for the present state of affairs on the neglect of the technical institutions of the country to recognize and accept this duty.

"The regard for school education is not singular with the American people but it has been singularly universal with them, and a comprehensive educational system has resulted which reaches even to the remote byways of the country. An educational system which meets the needs of the country, however, must be something more than a mere comprehensive school system in touch with the people. It must not only offer education in general, but it must also offer those special educations which are necessary for the fullest development of each branch of human endeavor and service. In satisfaction of this condition, the great variety of professional schools have been established,—divinity schools, law schools, medical schools, schools for the professional engineer,—and on the other hand, trade schools of various characters. In the latter respect, however, this nation has been at fault. Some trades schools have been established and maintained, and manual training has come to be highly regarded,—perhaps too highly regarded in the high schools though insufficiently established in the grade schools; but the development of trade schools has been insufficient to the country's needs, and foremen's schools are still almost unknown."

Lavish appropriations for educational purposes have been made by both Federal and State Governments and with excellent results, as evidenced by the work of the great State universities of many of the western states. But the demand for university-trained engineers has been so great that the activities of state colleges have been limited to professional engineering work. Agricultural education has also made large inroads on the public funds and agricultural schools have been developed out of all proportion to the needs of the agricultural section of the population as compared with those of the manufacturers. There is a widespread belief in the fallacy that the prosperity of the country depends upon its agricultural resources and the agricultural community has selfishly clamored for funds which should have been applied to industrial education.

"The engineering schools, like their friendly rivals, the agricultural schools, have before them a field which may be divided into three parts—a triple field—two parts being semi-professional or completely professional and the third vocational and subordinate to the others. The engineering schools have only occupied one effectively, though a few are now growing towards an occupation of a second.

"These three parts to which I refer are the divisions of the educational scheme of the nation in which fall: (a) Engineering research and the advanced professional instruction which is being given here and there to a few graduate students; (b) The engineering courses of study as they are now ordinarily planned; and (c) The instruction of artisans and especially instruction adequate to the needs of industrial foremen or sub-superintendents, that is, master craftsmen.

"The second of these educational divisions in the order here named, it seems to me the engineering schools are occupying very well, but even here there is a lack of effectiveness which seems due to lack of correlation between the schools and lack of study of pedagogic history by those persons responsible for the direction of the schools. Reasonable independence and individuality in methods of teaching is due to the individual men who are experienced and worthy in each school, and the individuality of the several schools must not and cannot be infringed; but unhappily in the past, there have been contrasts of pedagogic views and professional ideals that cannot be justified, for in these things (matters of judgment though they be) truth can lie only in one direction, however diverse may be the paths over which she may be approached.

"It is to the third educational sub-division that comes distinctly within the purview of the influence and direction of the engineering schools though preferably not within the scope of their curriculums that I direct your attention. This is the instruction for artisans, and particularly the instruction intended for foremen and sub-superintendents. . . . The secondary industrial schools of the country are utterly without adequacy in numbers or extent to meet this problem in secondary education; and the schools suitably planned for the appropriate education and improvement of foremen are almost unknown with us.

"I lay this latter fact at the door of the engineering schools, and hold that the members of the faculties are not guiltless unless they make adequate efforts to get filled this need in education for master craftsmanship in the industries, which comes within the purview of their influence and direction.

"The governing boards of the engineering schools must divide the guilt with the faculties, if they continue their common failure to provide sufficient teaching force in the engineering departments, thus putting any effort which reaches beyond the routine of the department curriculum and touches the larger interests of the industrial body beyond the physical endurance of the individual members of the faculties.

"Governing bodies have also been at fault heretofore by too close adherence to a standard for engineering teachers in which mere ability to impart information in the class room, without consideration of any breadth of ambition, has held too predominant a place in the selection of men, and breadth of view in industrial affairs accompanied by clearness of judgment has had too small a place. I do not undervalue the technical ability to impart information in the class room, and assent that this should be properly given much weight in selecting men for the engineering faculties; but this ability, however largely developed and however fully accompanied by engineering skill is far from sufficient to make an adequate member of an engineering faculty.

"The acts of many governing bodies heretofore are in some degree excusable in consideration of the breathless growth of engineering schools which has seemed to make impracticable any pause for thought or consideration of needs beyond those of the day's pressing want of active teachers and suitable appliances to give strength to their teaching. It seems to me less excusable that so large a proportion of the leading men in the engineering schools should neglect on their own part a due consideration and study of pedagogic history and the development of the lines of philosophy and sound pedagogic thought, which lead inevitably to broader sympathies and more comprehensive professional views. An engineer who has cultivated a correct professional spirit ought to recognize promptly and appreciate fully the importance of careful study of professional precedents of the best types, and if the engineer is also a teacher, he seems to be under obligation to take a comprehensive view of both sides of his vocation, the side of engineering and the side of education.

"I believe that such views lead emphatically to the proposition that engineering schools are called upon to extend their influence so that they will continue their present work of education for the scientific engineer; advance the work of engineering research and advanced professional study; and also foster the establishment, maintenance and development of polytechnic schools for master craftsmen. . . . Such schools supported by endowments or by the state could wisely be founded in each large industrial center, but in each instance the school government needs the combined interest, activity and support of the better manufacturers and of suitable members of the faculty of a great engineering school. It must always be borne in mind that these schools should equally assist the craftsmen and the industries employing them, and thereby improve the fitness and promote the prosperity of the state."

Besides the selfishness of the agricultural class mentioned above, two other causes militate against the development of industrial education. The first of these is the opposition of trade unions to the spread of education calculated to develop the special capabilities of each man and accentuate the differences between the abilities and earning power of individuals. This form of opposition is however gradually decreasing among the more influential labor organizations and may be expected to die out in time. The second cause lies in the fact that the men who have made fortunes through manufacturing industries and transportation rarely give of their riches to advance the condition of the industries through association with which they have come to wealth, preferring to found art galleries and museums, rather than industrial schools. "While asserting that I fully appreciate the fine influence of art galleries and museums, I also insist that at the present juncture of education in this nation any man with a fortune to bestow can do a more pervading good by aiding the engineering schools to develop the work of engineering research, and by establishing schools for industrial foremen to be directed with the assistance and advice of the engineering schools.

"Our communities maintain manual training schools and here and there a trades school, and great professional engineering schools are maintained in the east by private endowments and in the great states of the west by appropriations from the state governments; but there still remains a gap in industrial education which lies between the elementary trades schools and the professional engineering schools of university grade. This gap must be filled and it will be filled promptly if the men who are and who ought to be members of this society do their duty. It is imperative to give to the thousands of young men who are to make the bulk of the corporals and sergeants of industry that education which makes for self-support in the best sense, makes for proper parentage, and makes for a good grade of thoughtful citizenship (to which foremen's schools may be directed in keen fashion) before the education which lends figure and charm to a man's recreations (such as so fortunately comes from the art galleries and museums) is taken up. I believe that no use of money can bring greater returns to the state, or greater satisfaction to the giver who understands the educational situation, than large gifts for the purposes of industrial education."

BREATHING APPARATUS FOR USE IN MINES.

EXTRACTS FROM THE REPORT OF THE ROYAL COMMISSION ON MINES DEALING WITH THE DEVELOPMENT AND APPLICATIONS OF BREATHING APPLIANCES.

Report of the Royal Commission on Mines.

THE first report of the Royal Commission on Mines, recently published, deals with only one element of the inquiry outlined for them by the Home Office. Very few sittings of the Commission had been held before it was decided that confusion and delay might result from taking testimony simultaneously on all questions bearing on the problem of safety in mines, and therefore within the scope of the inquiry. Hence, for the greater part of the past year, the Commission have given their exclusive attention to the questions of the compulsory watering of roads in dry and dusty mines, and the provision and use of breathing appliances as a means of facilitating the work of rescue in the event of an accident. The report just published deals with the latter of these two questions and presents a very clear discussion of the history and present development of breathing appliances and of their applications.

Several of the leading types of apparatus were tested under the direction of the Commission, most of the tests, however, being made in the laboratory. The desire of the Commission was not to obtain exhaustive data as to the practical working of the various appliances, but merely to show how far their functioning complied with the requirements of the human subject under different conditions. The tests and results are described at length in an appendix to the report. The following abstracts give only the general conclusions arrived at by the Commission.

"The results of the experiments are in our opinion satisfactory, and show that the existing appliances have been greatly improved as compared with the earlier types. The report, however, shows that there are defects, some of a trivial and others of a more serious character, in each apparatus, and in drawing attention to these defects the Commission hope that the criticisms passed will lead to improvements being made. The appliances generally give indication of steady development, largely as a result of practical experience, and the Commission feel that they cannot lay too much stress on the need for further experimental trial under suitable conditions.

"After fully considering the results of experience here and abroad, we are of opinion that the question is ripe for further development in this country, and demands the serious attention of the industry. We have considered whether it would be desirable to make the provision of any of these appliances compulsory, and we have come to the conclusion that sufficient advance has not been made in this country to justify such a course at present. A good deal of experience is required both as to their working and the best system of training men before their use can be properly appreciated. The readiness of mine owners in the United Kingdom to adopt any precautions which may lead to the diminution of the risks of mining is well recognized, and we feel confident that the necessary steps towards a systematic use of the appliances will be taken by them without delay.

"We make no recommendations as to the

use of any particular appliance. The various types are steadily developing and it is desirable that further trials should be made. Ultimately, when more experience has been gained, there would be obvious advantages in securing the use of a uniform type in the same district.

"We do not wish to convey any false impression by suggestion that the provision and use of breathing appliances is likely to lead to any considerable decrease in the number of lives lost by explosions. Exaggerated expectations of their utility in saving life in mines have arisen in some quarters. On the other hand, many practical mining engineers have, we think, too hastily formed the opinion that in face of all the real difficulties in rescue work, and the element of risk involved in their use, breathing appliances are not likely to be of any real service. We desire, therefore, briefly to indicate the circumstances under which they may prove useful, if proper training and efficient organization are secured.

"Apart from actual rescue work, breathing appliances may be of great service in making it possible to deal with underground fires more safely and effectively than would otherwise be the case. In the event of a gob-fire, for instance, the seat of the fire may, on account of smoke, be inaccessible without great risk, and in such a case breathing appliances could obviously be used with much advantage in exploring and directly attacking the seat of the fire, in building stoppings close up to it, and in preventing the poisonous fumes from menacing the safety of men beyond. Breathing appliances, including smoke helmets supplied with fresh air through a pipe, are now frequently used for this purpose in Westphalian and Austrian collieries, where gob-fires are not uncommon. In a report on a recent visit to the Westphalian coalfield it is pointed out that 'the pecuniary advantages resulting from the use of apparatus for penetrating irrespirable atmospheres and water has had quite as much to do with their general adoption in Westphalian mines as the desire to have the means at hand for saving life.' Some British collieries are seldom free from gob-fires or dangerous heating; these fires often cause not only danger to life but great loss of property to coal-owners, and loss of employment to men. Hence, there seems to be a considerable field for the use of breathing apparatus apart altogether from rescue work after explosions.

"In the event of an explosion anything which facilitates the rapidity and safety with which the ventilation can be restored and the after-damp removed must contribute towards the saving of life. Most of the deaths are caused by after-damp, and men are frequently alive for a considerable time after the explosion has occurred. Delay is often caused by uncertainty as to whether fires exist, or the impossibility of dealing with them if they are present, or else by difficulty in getting through airways in order to restore the ventilation. The use of breathing appliances may obviate some of this delay, and facilitate in various ways the work of exploring the mine, in rescuing any man found alive or any explorer affected by after-damp, and in 're-covering' the mine itself. We do not think that breathing appliances can play more than a subsidiary part in rescue operations after an explosion, but this part may sometimes be of considerable importance.

"Against the advantages to be obtained from breathing appliances, we must unfortunately place the risk attending their use. Accidents have occasionally occurred, owing to the apparatus being placed in inexperienced hands, or to failure to observe the necessary precautions. The regrettable accident at Courrières by which an untrained man lost his life while wearing one of the appliances, will be borne in mind in this connection. On the other hand, there are probably still greater risks in rescue operations conducted without special appliances, and it is to the honour of the mining community that these risks are willingly taken whenever there is a reasonable probability of saving life.

"We think, however, that the risks attaching to the use of the appliances can be reduced to a minimum by a proper system of training, and we desire to lay particular emphasis on this point. In the first place, it is important for purposes of training to select men who are most suited for special work of this kind on the ground of general intelligence, physique, and temperament. The men selected should then be given a thorough knowledge of the construction and working of the appliances, and should be accustomed by degrees to wearing them, at first in an experimental gallery and afterwards, when they have attained proficiency, in actual operations underground. Constant exercises at regular intervals under the supervision of a properly qualified instructor are essential.

"The best method of providing for the necessary training and practice is undoubtedly by the establishment of 'Central Rescue Stations.' This system, which consists in the establishment of a single station at a central point for the joint use of several neighboring collieries or a group of collieries, secures obvious advantages which will appeal to mine owners on the score of efficiency and economy. The value of this system has been recognized for some time in this country by the establishment of the rescue station at Tankersley. The same system was recommended in the reports made by the Committees of the South Yorkshire Coal Miners' Association and the Fife and Clackmannan Coalowners' Association, and it is understood that a similar recommendation has been made, and is being acted upon, by the Lancashire Coalowners' Association.

"The number of collieries included in a group for the establishment of a rescue station, and the method of organization, will depend largely on circumstances. One of the most important points for consideration is the need for having the appliances readily accessible in the event of a fire or an explosion, and the possibility of summoning, without delay, a sufficient number of trained men. In cases where the collieries are situated near to one another and there are facilities for bringing the appliances quickly to the spot, it may be arranged not only for the men to be trained at the station, but for the appliances to be stored there. In other cases, where the distances between the collieries are greater, and the means of communication are inadequate, such an arrangement might be found to be unworkable without the risk of serious delay in bringing the appliances to the scene of an accident. In such cases it might be better to arrange that each colliery belonging to the group should make separate provision for the storage and maintenance of a certain number of appliances in a suitable place at the surface, and that additional sets should be kept at the central station. Whichever system is adopted, it is manifestly necessary that the appliances should be placed in the charge of a thoroughly competent person, and should be constantly examined and cleaned and kept ready for immediate use.

"The rescue station will not only form the most sutable place for instruction and practice, but will become, under a proper system of organisation, a center from which men trained in the use of breathing appliances can be quickly obtained when the necessity arises. It may be anticipated that for some time it will not be possible to train more than a small proportion of the men employed at a colliery, and cases may arise in which outside assistance is required. It could be arranged by a system of co-operation between mines attached to the same station that the men trained there should, in cases of emergency, be available for service at other than their own collieries. The names of the men best suited for such service could be recorded by the officer in charge of the rescue station, and on the receipt of a message from a colliery that help was required, a well-trained and well-equipped corps could be sent without undue delay to assist the men belonging to that particular colliery."

NEW IMPROVEMENTS IN ARC LAMPS.

THE DEVELOPMENT AND ADVANTAGES OF THE MAGNETITE-ELECTRODE LAMP.

G. M. Little—National Electric Light Association.

DURING the last few years the development of electric lighting has been mainly along the lines of improvement of the incandescent lamp, the arc lamp having received comparatively little attention. Recently, however, some important improvements, leading to greater efficiency and economy, have been made in the latter, one of the most prominent of these being the development of the magnetite-electrode lamp. The following abstract of a paper by Mr. G. M. Little, presented before the National Electric Light Association, describes the advantages of these metallic-oxide electrodes and the development of a lamp suitable for using them.

"The magnetite electrodes were so named because magnetite is usually one of the constituents of the negative or cathode, but it would be more satisfactory to call them metallic-oxide electrodes, as, in addition to the magnetite, there are always at least two other oxides present—namely, oxide of titanium and oxide of chromium.

"These electrodes are made in a very different manner from the carbon electrodes. As is well known, the latter are squirted or moulded from a plastic mixture, and are baked, the carbon furnishing sufficient mechanical strength and electrical conductivity. A metallic-oxide electrode cannot be made this way, for it is a familiar fact that a fine powder is a poor conductor, no matter of what it is composed, and as these electrodes are made for the most part from finely powdered oxides it is evident that a conducting binder or a conducting case would have to be used. In practice, the mixture of oxides is tamped into a thin iron tube and the end sealed in an arc.

"The oxides have distinct and separate reasons for their presence. The titanium oxide has the property of rendering the arc luminous, and it may be here noted that the metallic-oxide arc is a flame arc, the light not coming from a crater as with carbons. The oxide of iron gives conductivity to the fused mixture when cold, the other oxides being conductors only when hot. The oxide of chromium prevents a too rapid consumption, so that by its use an electrode may be given a very long life.

"The positive, or anode, used with these metallic-oxide negatives is generally a metal, copper and copper alloys being used extensively, and is consumed much more slowly than the negative. This is contrary to what would be expected, judging by the action of the carbon electrodes.

"There are a number of advantages possessed by the metallic arc over the carbon arc. In the first place, the efficiency is much better; that is, a metallic arc lamp operating on a 4-ampere current with approximately 65 to 70 volts at the arc will give a light equal or superior to that of a 6.6 ampere, 75 volt, direct current, enclosed carbon arc lamp.

"The distribution of light is far better. This is owing to the fact that in the enclosed carbon arc practically all the light comes from the crater on the flat under-surface of the upper electrode, most of it being thrown down and not serving to illuminate the street between lamps. The light from the carbon arc itself is weak and of a blue colour. This is very pronounced at times, especially if the flat under-surface of the upper electrode is somewhat inclined, thus hiding the crater. In the case of the metallic-oxide electrodes, the arc is itself the source of light, practically none coming from the crater, except by reflection. The metallic arc is much like a candle flame, having its luminous and non-luminous zones. The light is brightest near that end of the arc which is next to the negative electrode, and comes from a hollow cone-shaped mantle of volatilised oxide of titanium rendered incandescent by the heat of the arc, just as in the candle flame the light comes from a hollow cone-shaped mantle of carbon particles made white hot by the heat of the flame.

"The voltage required to maintain a metallic arc is less than that of an enclosed carbon arc. It is a familiar fact that an enclosed carbon lamp will not burn properly with the arc voltage down to 65, while a metallic arc will burn well at less than 55. Metallic arcs are adjusted to burn at from 65 to 75 volts in different cases, while the carbon arcs are all set at 80. This is a very evident advantage in favour of the metallic arc, as more lamps may be put on a circuit without raising the voltage on the line.

"The life of carbon electrodes, as a rule, is not over 150 hours, while the metallic-oxide electrodes can go considerably longer.

"The uniform white colour of the metallic arc is in marked contrast to the changeable blue and white of the enclosed carbon arc.

"As the metallic-oxide electrodes are not burned 'enclosed' there is no inner globe required on the lamp."

The securing of all these advantages was not an easy matter. In the first experiments the electrodes were arranged as in the carbon lamp, that is, with the positive above and the negative, the metallic-oxide electrode, below. Several difficulties presented themselves. From the point of view of illumination the arrangement was not a success because first, a large shadow was formed on account of the bright portion of the arc being near the surface of the lower electrode; second, the fused slag on the lower electrode reflected a great deal of light upward; third, a reddish soot which obscured the light formed in spongy masses around the electrodes; and lastly, an unsteady arc was formed, due to the negative electrode burning to a blunt taper point. Mechanical difficulties were also apparent, the most important being that only a short metallic-oxide electrode could be used, and that, as the negative electrode was the more rapidly consumed, an under-feed mechanism was necessary. Hence it was found necessary to reverse the positions of the electrodes.

"The first attempt to burn the metallic-oxide electrode above and the metallic electrode below showed that there were serious obstacles to be overcome before it could become a practical method. In the first place, the electrode would not keep a square end, but would waste away on one side, and the arc would run up this bevel or slope, giving a very unsteady light. In the second place, the volatilized oxides of iron, chromium, titanium, etc., would condense on the sides of the electrodes and hang down as a fringe or curtain, hiding the light.

"The first means taken to overcome these troubles was the introduction of a rotating draft of air around the arc. This had the effect of forcing the arc to hold to a central position, stopped the crooked burning and steadied the light, but did not take care of the fumes. Attempts to blow the fumes away sideways gave only partial success. Finally, a current of air was directed down around the arc, and this gave excellent results. The electrode burned perfectly square, and the clean layer of air prevented any gathering of fumes. This was a very marked advance, as it did away with any need for a mechanical scraper or shaker, the soot practically all passing out of the chimney and not requiring to be caught in any receptacle, the globe remaining clean. . . . . . .

"The special conditions described with regard to draughts are obtained by a down-draught tube, which directs the current of air down around the electrodes, another current of air over the reflector and circling around the globe forming a means of protection to them, and a special construction of top and case for giving proper draught conditions when under all conditions of wind."

AMERICAN RAILWAY SECURITIES.

A FOREIGN ESTIMATE OF THE ECONOMIC CONDITION OF AMERICAN RAILWAYS AND THE CAUSES OF THE RECENT DECLINE IN THE VALUE OF SECURITIES.

G. M. Boissevain—Revue Economique Internationale.

PROBABLY no question in the United States is of such wide importance or touches so many interests as the present railway situation. From the traveling public the prevalence of wrecks and derailments raises a periodical storm of protest against alleged faults and negligence in management. Shippers are hampered by the shortage of rolling stock and the consequent delays in freight movement. Politicians in all sections of the country, reflecting the popular outcry against all classes of corporations, are agitating for a more or less radical degree of government control and regulation. These and other phases of the situation have been dealt with in former issues of THE ENGINEERING MAGAZINE. In the present number Mr. Gaines' article presents one of the economic problems, the physical valuation of railway properties. The following abstract of an article by M. Boissevain in a recent number of the *Revue Economique Internationale* discusses another question of economic interest, the recent decline in value of American railway securities.

In general the year 1906 was one of enhancement of values. Abundant crops, increased activity in the metal trades, and an enormous development of commerce gave to all sections of the country an exceptional degree of prosperity. The railways were overwhelmed with traffic and the receipts reached a point never approached before. Gradually, however, the tightness of money was beginning to make itself felt. More than once during the summer the marketing of securities suffered from this cause and there was some apprehension as to the result of the usual large demands of money for crop movements. At the same time it was clear that the public was not buying securities on the stock market. This reluctance was, however, considered as only temporary and had no effect on the optimism of professional traders, to whom the future presented nothing but increasing prosperity.

This optimism in Wall Street was greatly increased in August, when the semi-annual dividend of the Union Pacific was increased from 3 to 5 per cent., and the Southern Pacific announced its first dividend at the rate of 2½ per cent. semi-annually. These dividend declarations gave a still greater impetus to the bull movement. It was confidently predicted that other roads would soon follow the example set by these two, in declaring new and increasing old dividends; it was necessary only to hold out until the beginning of the year, when with the usual relaxation in the tightness of the money market there would be a rush of buyers for railway securities and a consequent profit to the traders. In fact, though the tightness of money increased rather than diminished, stocks were held fairly close to the high levels of the year during the last few months of 1906 and even experienced a slight advance after the new year. But, contrary to the expectations of the professional traders, the public still remained out of the market, and in March the bull market collapsed with a crash which carried the prices of railway securities in general much below the low levels of 1906. Subsequent movements have not enabled them to recover to their normal levels.

The first cause of this great depreciation in the value of railway securities was the fact that the prices to which stocks were forced before the crash had no foundation on the intrinsic value of the securities, but were merely the result of professional manipulation in the stock market. These fictitious values the holders of capital refused to consider as normal, and they were not supported by purchases of new issues of securities. The optimists felt that though the prices were too high on the basis of the last dividends just at the time, the great development of industry and commerce would soon place them on a sound basis with higher and rapidly increasing dividends. But this reasoning was absolutely fallacious. The position of the railroads was such as to make the expectation of increased dividends absolutely unjustifiable, because the need of new capital was being recognized more and more strongly, and it was not forthcoming. In order to obtain purchasers for new issues of bonds the railroads had to dispose of them at a sacrifice, and this showed that there was a tendency to hold out for greater investment returns, a fact which in itself made the lowering of the price of stocks imperative.

The expectation and prediction of a general increase in dividends was based on the great development of traffic with which the railroads were overwhelmed. But though increased traffic caused large increases in the gross receipts, the operating costs were increasing at an equally rapid rate. This was due to two causes, first, the large increase in the cost of labor and material of all kinds, and second, the fact that the railroads were not equipped to handle the enormous traffic and needed large amounts of money for new rolling stock and for extensions to lines and yards. Each month during 1906 the gross receipts of the larger lines as compared with the same month the year before showed a substantial increase, but the corresponding increases in the net receipts constantly grew smaller and smaller, until in the month of January, 1907, the net receipts showed a decline from those of January, 1906, notwithstanding a considerable augmentation of the gross receipts. The increases in gross receipts were being more and more absorbed by increases in operating costs and, in some cases, in fixed charges.

Here then was one cause which precluded the possibility of higher dividends. The other, paradoxical as it may seem, was the direct result of the increasing traffic. The general production of the United States has made enormous strides within recent years, and this growth was reflected in the railroad earnings. From 1895 to 1905 the total receipts of the railroads of the country increased from 1075 millions to 2082 millions, but in the same period the capitalization of the railroads increased only from $10,346,754,229 to $13,805,258,121. During this period the policy of the railroads, in coping with the annually increasing volume of business, was, generally, to make as few extensions to lines, and as few increases in capital, as possible. They devoted all their energies to improving existing lines, by reducing grades, replacing light with heavy rails, reconstructing bridges, etc. Rolling stock also had to be adapted to the new conditions, and old locomotives and cars had to be replaced by new ones of more modern design. As a consequence of these improvements in permanent way and equipment, large deductions had to be made from the receipts in lieu of making new loans. In a word, the railroads did everything possible to use their lines and equipment up to the extreme limit while extending their capital as little as possible.

At last, however, when this policy would no longer serve, when the railroads despite their best efforts found themselves overwhelmed with traffic, it became necessary to undertake the building of new lines, extraordinary improvement work, double tracking on trunk lines, extensions to stations and yards, and large additions to rolling stock. This could be done only at enormous expense, and when the financial world finally realized the magnitude of the works necessary to carry this new policy to a successful conclusion, there resulted a general panic. And, in fact, it was justified. Mr. Hill, one of the foremost authorities on railway affairs, has calculated that to place all the railroads of the United States in good condition would require an annual expenditure of at least a billion dollars for the next five years.

When the railroads finally awoke to the necessity for changing their policy there was a general rush for new capital. During the last few months of 1906 several companies began to issue new stock and to negotiate loans, and since that time new issues of securities have not ceased. According to some apparently credible calculations, the total of the new issues during the last half of 1906 was about 400 million dollars, and the new issues announced since the first of the present year reached the enormous total of one billion dollars, 600 millions of which have already been put on the market. The impossibility for the market to absorb these enormous issues was the great cause of the decline in the prices of railroad securities.

A final cause of the decreased values is to be found in the governmental and popular agitations against the railroads. This had its origin in an attempt to remedy some abuses of power on the part of the officials of some of the roads, but has developed into a general attack with the final object of bringing the railroads under government ownership. This is having a temporary effect on railroad securities, but there seems to be little to cause alarm as to the ultimate outcome. It can safely be left to the good sense of the American people to give the railroads, which have been so largely instrumental in the building up of the country, full opportunity for further development without unfair limitations.

THE DEVELOPMENT OF THE MOTOR BOAT.

EXAMPLES OF MOTOR BOATS OF VARIOUS TYPES RECENTLY INTRODUCED IN EUROPEAN NAVIES.

W. Kaemmerer—Zeitschrift des Vereines Deutscher Ingenieure.

THE rapid development of the motor boat during the past few years has been one of the direct results of the enormous growth of the automobile industry, which has given an impetus to so many allied interests. Motor-boat building can as yet scarcely be called a separate industry, but that it is rapidly attaining that position is evidenced by the large number of firms who are interesting themselves in its development and by the attention which is being paid by engineers to the problems connected with the application of the internal-combustion engine to marine propulsion. An interesting sketch of the development and present status of the motor boat was recently given by W. Kaemmerer before the *Verein Deutscher Ingenieure*, of which the following is an abstract.

When one considers the share of the

various countries in the development of the motor boat, the industry is seen to be a direct result of the development of the automobile, for France has taken first place in motor-boat building also. This applies, of course, less to boats for commercial and general use than to racing craft, in which department French builders have been unusually successful. That racing trials, for which such boats were primarily built, have an important technical value aside from their sporting interest is easily seen from the progress of French motor-boat building, which certainly would not have attained its present status if the stimulus of the racing fever had been lacking. One of the most important results which must be attributed directly to the prevalence of the sport in France was the gradual lessening of the weight of the motor. Some of the results obtained in this direction were quite wonderful, the Société Antoinette, for instance, producing a motor which had the almost incredibly small weight of 1 to 1.5 kilograms per horse power and was, at the same time, an efficient and safe machine. To the influence of racing must also be attributed a great deal of the development of the motor boat in Italy, where it has attained a high degree of perfection. All the principal firms connected with the industry produce the boat complete and on that account have attained excellent construction. In England, Germany and the United States motor-boat building seems to have been taken up more on the practical and commercial side, and, although some firms in each country make a specialty of racing craft, by far the larger number of boats built are designed for commercial and general service. The United States leads in the number of firms which produce motor boats as a part of their regular output and many of them are attempting to build up a large export trade by the establishment of branch houses in Europe.

The applications which may be made of the motor boat are very numerous, but, aside from pleasure craft, the greatest interest has been paid to its applications in the navy and its associated interests. The Italian navy has been especially active in this regard though the navy departments of other nations have not been far behind. That the motor boat has not had a more rapid and general development is due to the peculiarities of the internal-combustion engine in its present condition. Of these high speed and low efficiency of screws and the difficulties of reversing and speed regulation have been the most important factors in retarding development. The difficulty of speed regulation is a great drawback in heavy weather: to maintain a high speed in a small boat on a heavy sea results in filling the boat so full of water that it must either capsize or sink. The question of fuel is still unsettled. The use of benzine is attended with great risk of fire unless great caution is used. Recently the effort has been made to substitute petroleum or other heavy oils for the commonly used benzine. The general introduction of these oils would greatly reduce the risk of explosions and also operating costs, but would necessitate alterations in the design of motors.

The British navy seems to have in view the application of internal-combustion motors to larger vessels, which, unlike the auxiliary boats of the larger ships of the squadrons, are designed to constitute a distinct fighting unit. These are what are known as motor torpedo boats. The first representative of this class was brought out by Yarrow and Co. in 1906. The vessel is 18.28 metres long and 2.74 metres beam and the draught is from 0.3 to 1 metre. Tried without load it reached a speed of 25.5 knots, and, with a 3-ton load, 24 knots. The boat was propelled by three benzine motors of a total of 300 horse power, working three shafts at a speed of 1000 revolutions per minute. The outer machines have eight cylinders, and the middle motor, four. The former can be used only for going ahead, but by means of a reversing gear the boat can be run astern on the middle motor.

The general introduction of this type of torpedo boat would get back to the original design in the introduction of the torpedo arm into naval service. This was to put in service large fleets of small but very swift boats, offering the smallest possible target area and armed only with torpedoes, which were to attack hostile ships in great numbers. But the size of torpedo boats has steadily increased until now they resemble small cruisers and are rarely under 50 meters long and of a displacement of 500 tons. It is doubtful that these large boats are any more effective than smaller ones would be.

For use in war the small cost of the Yarrow model is a strong point in its favor. For the cost of the "Dreadnought" about 350 torpedo vessels of this class could be put in service. The great advantage of the motor torpedo boat is its small weight of only eight tons. It is therefore possible to transport it by rail, an advantage which might be of the utmost importance in time of war in providing a harbor, attacked from the sea, with new and important means of defense.

In 1905 ten motor torpedo boats were built in America for the Russian navy, after designs by Mr. Lewis Nixon. These were somewhat larger than the Yarrow model, but still light enough for transportation by rail. On the other hand their speed, of 20 knots, was considerably smaller than that of the former model, but in their design the highest possible speed was not the prime consideration. These boats are 27.43 metres long, 3.35 metres wide, and draw 1.2 metres of water with a load of 34 tons. The weight of motors and fuel amounts to 15.5 tons, and with this amount of fuel they have a sphere of action at full speed of 400 knots. The small American torpedo boats on the other hand built for similar speed have a displacement of 51 tons and a sphere of action of from 100 to 160 knots. The Nixon boats are propelled by two six-cylinder benzine motors working on two shafts and reversed by means of compressed air. The armament consists of a deck torpedo tube for torpedos of 450 millimetres diameter, a 4.7 centimetre quick-firing gun and several machine guns. These boats are very seaworthy, as was shown by a voyage made by one of them under its own power from New York to the Black Sea during fairly rough weather.

A boat similar in construction to the Yarrow model but somewhat smaller has been built by Fiat-Muggiano for the Italian navy. It was designed as a torpedo-armed auxiliary for warships, but may be applied to similar service as the British boat, though its speed is only 15 knots. This vessel is 13 metres long and 3 metres wide. It is propelled by two benzine motors of a combined power of 200 horse power, working on the same shaft and started and reversed by compressed air. The total weight of the vessel, including machinery, is 7 tons. Fuel for an 180-knot voyage can be carried in tanks arranged forward and at the sides. The armament consists of two 356 millimetre torpedo tubes, a 4.7 centimetre quick-firing gun and two machine guns. A later boat built by the same firm was 11 metres long and had a displacement of 5 tons. It was driven by two 60 horse power motors on the same shaft and reached a speed of 17 knots. For tenders the Italian navy uses motor boats almost exclusively. The vessels built for this purpose by Fiat-Muggiano are 8.5 metres long, 2.35 metres wide and 0.58 metres draught. The displacement with a crew of sixteen men and 200 kilogrammes of fuel is 3.2 tons. For the service for which these boats are designed an average speed of 8.5 knots is sufficient and this can be maintained by a 20 horse power motor. At this speed enough fuel for a 24-hour run can be carried.

Although the German navy has as yet built no motor torpedo boats, several vessels propelled by internal-combustion engines have been placed in various services and the question of their general introduction is being considered. In 1903 the Daimler Company built a small vessel for general service in the torpedo department of the Kiel navy yard. This boat was propelled by an 8 horse power petroleum motor which was the first motor using this fuel to have electric ignition and to be started by benzine. Since that time many other boats have been built for use in the navy, nearly all of them using petroleum as fuel owing to the much higher price of benzine.

Probably the most important motor boat employed in the German navy was built by the Daimler Company for torpedo testing at Kiel and is used also for short voyages by the higher officers of the fleet. This boat is 17.7 metres long and 2.40 metres beam, and the immersion of the screw with 7 tons displacement is 1 metre. The metacentric height with 600 kilograms of fuel and a crew of six men is 450 millimetres. The boat is propelled by a 300 horse power, six-cylinder motor which is located amidships. To the rear of the engine room is placed a fuel tank with a capacity of 750 litres. This amount of fuel is sufficient for a 6-hour voyage, but for longer trips other tanks can be carried easily. The fuel is ordinary lamp oil and the consumption is roughly 0.32 kilogram per horse power hour. The speed of the motor is from 800 to 900 revolutions per minute. In spite of the high power of the motor it is reversed by a hand-operated reversing clutch. The starting is also by hand, the fuel being drawn through the carbureter into the cylinder by a small hand pump. The average speed attained is 19 knots.

ELECTRICAL TRANSMISSION GEARS ON MOTOR VEHICLES.

A SUMMARY OF THE TYPES OF ELECTRICAL TRANSMISSION USED ON HEAVY VEHICLES.

A. A. C. Swinton—Institution of Civil Engineers.

THE following abstract of a paper presented before the Engineering Conference of the Institution of Civil Engineers gives an interesting summary of the systems of electrical transmission now used on motor vehicles, particularly those of the heavier types.

"In view of the somewhat barbarous method of gear-changing at present in vogue on most petrol-driven motor-vehicles, and of the fact that, crude as it is, this method continues to hold its own against all other mechanical devices, it is not surprising that attention has been turned to electrical arrangements for arriving at what is required, especially in the case of the heavier description of vehicles.

"Apart from the mere transmission of the motion of the engine crank-shaft, usually with a considerable reduction in the number of revolutions per minute, to the road-wheels, the chief requirements are: (1) an easily-operated and preferably automatic variability of gear ratio, so that full advantage may be taken of the maximum effort of which the engine is capable without over-running in obtaining the highest possible acceleration and speed for the vehicle under varying conditions of gradient, load, and surface and other resistances; (2) perfect control of the speed of the vehicle under different conditions beyond the variations of which the petrol-engine is capable; (3) ready disconnection of the engine from the road-wheels, so that the former can continue to run while the latter are at rest, coupled with means for gradual reconnection, so that the vehicle may start smoothly and without shock.

"Important considerations that have to be taken into account in comparing electrical and mechanical methods of arriving at the above requirements are: ease of working, reliability, and freedom from breakdown and derangement, weight, efficiency in terms of the power lost in the transmission, first cost, cost of upkeep, quietness, and freedom from vibration.

"Several arrangements of electrical transmission have been adopted, and, with varying details, may be described as follows:

"(1) The engine, which is preferably fitted with a governor, drives a dynamo which supplies energy to an electric motor, which in turn drives the road-wheels through the usual mechanical differential gear. An electrical controller of some description is fitted, so that the electric current can be so varied as to regulate the speed of the motor, while, either by means of the controller, or automatically by special windings on the dynamo and motor, the full power of the engine at its most efficient speed can be employed to generate constant watts made up of either a large current at low voltage, such as is required for starting and on steep gradients, or a small current at a higher voltage for running the vehicle at high speed on the level, with corresponding variations under intermediate conditions.

"(2) Similar to No. 1, excepting that the axes of the dynamo and motor being arranged in line, a clutch of some description is arranged between them, so that at top speed they can be mechanically connected together, and electrical driving and all consequent losses dispensed with, the armatures of dynamo and motor acting merely as fly-wheels. In this arrangement the electrical drive is only employed for starting, and at other times when the power of the engine is insufficient to propel the car on the direct drive.

"(3) The engine drives a dynamo, as in the previous cases, but instead of one motor, two or more are employed, each driving a separate wheel. The mechanical differential is thus dispensed with, but the direct drive, as in No. 2, cannot be arranged for. The two or more motors can either be arranged in the hubs of the wheels, when all gearing is dispensed with, or can drive the wheels through chain or toothed-wheel reduction gear. The latter are the arrangements usually employed, as unless some form of speed reduction is used, the motors are of necessity relatively very heavy. The employment of two or more motors enables the series-parallel system of control, so much used on electric tramcars and trains, to be adopted on motor vehicles.

"(4) A storage battery of comparatively small capacity, but capable of giving large discharges for short intervals, can be employed with any of the above-mentioned systems, the arrangement being such that for starting, or on hills, the battery discharges and assists the engine and dynamo in driving the motors, while at other times a part of the power of the engine is absorbed in charging the battery, the change being automatically effected by the relative voltage of the dynamo on the one hand, and of the battery on the other.

"(5) In another method, in which a storage battery is used to assist the engine when required, there are no separate dynamo and motors; but on the shaft of a mechanical transmission is fixed the armature of a machine which performs the functions of both dynamo and motor as required, automatically charging the battery when the engine has power to spare and the speed increases, and taking a discharge from the battery and acting as a motor, so as to assist the engine when the latter becomes overloaded and the speed diminishes.

"These systems with auxiliary batteries possess the advantage that, as the battery affords a ready means of starting the engine, the latter can always be stopped when the vehicle is at rest.

"Where storage batteries are employed, continuous currents are necessary, and, apart from this, most of the systems so far used have been on the continuous-current principle, which gives large changes in gear-ratio more readily. On the other hand, multi-phase alternating currents have already been employed with some measure of success, and are a matter of considerable interest, as with them commutators and brushes, and their attendant troubles and expense, are avoided, except in the case of the comparatively small exciter dynamo that is usually employed."

AUDIBLE RAILWAY SIGNALS.

A DESCRIPTION OF THE MECHANISM AND ADVANTAGES OF A SYSTEM RECENTLY INSTALLED ON BRITISH RAILWAYS.

W. Dawson—Institution of Civil Engineers.

THE great difficulty in the use of visible railway signals, even when in perfect working order, has been their liability to obscurement during snowstorms or foggy weather, and the invisibility of signals has often been pleaded as an excuse for accidents occurring under such conditions. Various means have been tried to remedy this defect, among them being the use of special detonator fog signals and, more recently, artificial fog dispersion, but it has been found that absolute dependence could be placed in none of these systems. According to a paper presented by Mr. W. Dawson before the Engineering Conference of the Institution of Civil Engineers, however, the problem has been solved on one of the larger English lines by the installation of an audible system of signaling, which is apparently reliable under bad weather conditions and besides possesses several advantages for constant use over the visible type. The following full abstract of the paper describes the mechanism and outlines the advantages of the system.

"The outdoor visible signals on our railways have been found satisfactory when the atmosphere is clear, either by day or by night, but on the descent of a fog they need to be supplemented or replaced by something which is audible. It has been felt by railway officers, and by the inspecting officers of the Board of Trade, that no device would meet the requirements of the situation unless it would give the driver of a train a distinct audible 'danger' signal, and a distinct audible 'all right' signal; further, that the device must not depend on electricity to give the 'danger' signal, and that should there by chance be any failure in the mechanism the result must be the sounding of the audible 'danger' signal.

"Such an apparatus has now been designed, and has been in use on the Great Western Railway on a short branch double line for fifteen months, supplementing the ordinary fixed outdoor visible signals as a first test; and as a more advanced experiment it has been in use for the past five months on a single line—22 miles long—in total substitution of the semaphore distant signals, which have been removed. During these experimental periods the apparatus has given great satisfaction, and the drivers and their officers have every confidence in it. The inspecting officers of the Board of Trade also have expressed their satisfaction with it, subject to the Great Western Railway Company reporting to the department at the end of six months' trial the result of the extended experiment.

"The main features and advantages of the system are as under:

"The parts consist of a slightly arched piece of timber, 40 ft. to 60 ft. long, bolted to the sleepers midway between the two running rails, on top of which is bolted a bar of T iron, suitably mounted and insulated, the bar being electrically connected by means of a length of telegraph wire to a switch at the signal-box. This bar is electrified by pulling a lever when it is desired to give the 'all right' signal. There is no moving part in this ground apparatus. This fixed, non-movable sloping bar also serves the purpose of lifting a rod connected with a mechanical device, fixed beneath the engine, of a standardised design to fit any engine. The lifting of this rod opens a small steam-whistle fixed in the cab of the engine when it is desired to give the 'danger' signal. To give the 'all right' signal, the action set up by the electrified bar on the ground apparatus restrains the whistle from blowing, but rings a bell. When the whistle or the bell sounds, either continues to do so until the driver shuts it off; and, without any further action on his part, it is ready to produce the same signal at the next station.

"Neither frost nor snow prevents the operation of the 'danger' signal. The system is applicable to both double and single lines, and works satisfactorily whichever end of the engine may be leading. The 'danger' signal will always be given should there by any chance be a failure of the electric action. Each signal being audible, it does not reduce the constancy of the driver's 'look-out' ahead. The arrangement will save all fogging expenses for those signalling posts at which it may be fixed.

"It operates during daylight, darkness, or foggy weather, and will bridge over the doubtful period between the time when a fog begins and the time when the fogman arrives at his post; and, even then, it is infinitely to be preferred to the fogman himself. It will avoid also the serious disorganisation to the train service, which now occurs even with the most approved detonator system of signalling. The detonator system of signalling, although the best hitherto devised, cannot claim for itself perfection, being subject to the possibilities of no explosion, or of the detonator being skidded off the rail. Even the fogman himself, without the knowledge of the man in the signal-box, may become disabled by accident, exposure, or indisposition.

"Seeing that the device is available at all times and in all states of the weather, it follows that fixed distant semaphores are not needed, and their cost, maintenance, and lighting need not be incurred. The Great Western Railway Company have removed them altogether on the single branch line already referred to.

"The use of the system may be extended, with the slight additional cost of the ground apparatus unelectrified, to give a 'danger' signal as a reminder to drivers to be prepared to run at the required speed over portions of the line where a reduced rate is ordered.

"The ground apparatus can be fixed at any desired distance from the home signal, in tunnels, on viaducts, and round curves in cuttings, and thus get rid of many difficulties which now beset railway officers in fixing a site suitable to ensure a driver getting a proper view of the signal."

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(3) A descriptive abstract,
(2) The name of its author,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING

BRIDGES.

Aqueducts.

Aqueduct Bridges on the Illinois and Mississippi Canal. Fred W. Honens. Illustrated description of aqueducts which carry this canal over the more important streams. There are nine in all, varying in length from 4 to 10 spans of 35 ft. each. 2000 w. Eng Rec—June 29, 1907. Serial. 1st part. No. 85324.

Bascule.

Bascule Bridge for the Corporation of Portsmouth. Illustrates and describes a bridge having two equal bascules, fitted with a complete electric equipment for raising them. 1000 w. Engng—July 5, 1907. No. 85592 A.

Rall Bascule Bridge Over the Illinois River at Peoria. A recently completed double-leaf bascule bridge of the Rall type is illustrated and described. 700 w. R R Gaz—July 5, 1907. No. 85467.

Some New Bascule Bridges. Brief illustrated descriptions of bridges of the

Rall type and Scherzer type, at Peoria, Ill., and the Page type, at Chicago. 1800 w. Eng News—July 18, 1907. No. 85734.

Blackfriars.

The Widening of Blackfriars Bridge. Plan and description of this interesting engineering work now in progress in London. 1500 w. Engng—June 28, 1907. No. 85502 A.

Double-Deck.

The Bridge Over the River Wear at Sunderland. Illustrated description of interesting construction work in connection with the erection of this double-deck railway and road bridge. 2-page plate. 1600 w. Engng—July 12, 1907. No. 85870 A.

Lift Span.

New Lift Bridge Over the Buffalo River. Illustrated description of one of the largest lift span bridges ever built. 700 w. Ir Trd Rev—July 11, 1907. No. 85528.

Manhattan.

The Brooklyn Anchorage of the Manhattan Bridge. Contractor's Plant and Progress. Gustave Kaufman. An illustrated descriptive article. Discussion. 8500 w. No. 69. Pro Brooklyn Engrs' Club—1906. No. 85975 N.

Piers.

Methods and Cost of Constructing Six Crib Piers, Three Howe Truss Spans, and One Steel Draw Span. The present article deals with the construction of the piers, near the mouth of a river 19 ft. deep at extreme low tide, the top of the piers being 40 ft. above the river bed. 1800 w. Engng-Con—July 24, 1907. Serial. 1st part. No. 85902.

Pontoon.

A Floating Bridge with Arrangements for the Passage of Boats (Schwimmende Brücke mit Schiffsdurchlasz). R. Weyland. An illustrated description of a foot bridge over a canal at Stettin, Germany, one section of which can be drawn aside to allow boats to pass through. 3000 w. Zeitschr d Ver Deutscher Ing—June 29, 1907. No. 85682 D.

Reinforced Concrete.

The Reinforced-Concrete Railway Bridge Over the Rhone at Chippis (Eisenbahnbrücke in Armierten Beton über die Rhone bei Chippis.) Illustrates and describes the design and construction of this bridge in Switzerland. 3500 w. Serial. 2 parts. Schweiz Bau—June 22 and 29, 1907. No. 85638 each D.

Removal.

Removing a Historic Bridge. An illustrated account of the removal of 4-track swing bridge, near 175th St., New York City, carrying the tracks of the N. Y., N. H. & H. R. R., which is to be replaced by a 6-track Scherzer rolling lift bridge. 1500 w. Eng Rec—June 29, 1907. No. 85321.

Steel.

Renewing the 50-Metre Span Bridge at Kedoeng-Djattie on the Samarang-Vorstenlanden Railway (Vernieuwing der Vakwerkbrug van 50 M. dagwijdte te Kedoeng-Djattie in den Spoorweg Samarang-Vorstenlanden). Illustrates and describes the design and construction of this steel bridge in the East Indies. 4500 w. De Ingenieur—June 29, 1907. No. 85692 D.

Viaducts.

Brush Creek Viaduct on the Alabama Western-Birmingham Extension of the Illinois Central. Views, plan and description of a viaduct near Haleyville, consisting of 75-ft. deck plate girder spans, 9 towers with 40-ft. deck plate girder span and two 60-ft. deck plate girder approaches. 800 w. Ry Age—July 26, 1907. No. 85968.

The Moodna Creek Viaduct, Erie R. R. Plan and description of a viaduct designed for a double-track superstructure. 2500 w. Eng Rec—July 6, 1907. No. 85455.

CONSTRUCTION.

Coast Protection.

Some Improvements on Galveston Island. F. E. Lister. An illustrated account of the sea-wall, and other protective works carried out, and the work of raising the grade, describing the novel and effective method of handling the filling material. 1500 w. Purdue Engng Rev—1907. No. 85929 N.

Cofferdam.

Difficult Cofferdam Work on Decomposed Rocks. Describes work at the foot of East 116th St. on the Harlem River, New York City, where troublesome conditions were overcome by simple expedients. 1200 w. Eng Rec—July 13, 1907. No. 85539.

Columns.

Heavy Columns in the Metropolitan Tower, New York. Describes the treatment in the design of the cross sections, details and connections of the principal columns for this structure which is to have a height of 668 ft. above the sidewalk. Ills. 1000 w. Eng Rec—July 13, 1907. No. 85540.

Earth Pressure of Column Foundations. (Der Bodendruck der Saulenfundamente). Adolf Francke. Mathematical discussion with diagrams. 5500 w. Oesterr Wochenschr f d Oeffent Bau—June 8, 1907. No. 85674 D.

Concrete.

Some Details of Concrete Construction. L. J. Hotchkiss. Illustrates and describes some of the methods used on recent work.

7500 w. Jour W Soc of Engrs—June, 1907. No. 85724 D.

Contractor's Plant.

Rapid Blast Furnace Foundation Work. Charles M. Ripley. Illustrated detailed description of the contractor's plant for constructing the foundations for the 10 blast furnaces of a new steel plant at Aliquippa Park, Pa. 2500 w. Ir Age—July 25, 1907. No. 85878.

Dams.

The Dam with Subterranean Flood Sluices at Marklissa (Le Barrage avec Evacuateurs de Crues Souterrains de Marklissa). A. Dumas. A description of this dam on the Queis in Germany, at which the flood water is carried off through subterranean conduits. Ills. 6000 w. Génie Civil—June 15, 1907. No. 85616 D.

See also Civil Engineering, Water Supply.

Failure.

The Failure of a Reinforced-Concrete Building at Philadelphia. Illustrates and describes the failure, on July 9th, of a three-story and basement building in course of construction at 15th St. and Washington Ave., due probably to premature removal of supporting struts. 1200 w. Eng News—July 18, 1907. No. 85739.

Gasholders.

The Development of Gasholder Construction. George H. Cressler. Read before the Wisconsin Gas Assn. A review of the three main periods of development. 2000 w. Eng News—July 11, 1907. No. 85576.

Levees.

Gravel Spreader Used on the Colorado River Levee Construction. H. T. Cory. Illustrates and describes a simple, cheap and efficient spreader designed by Thomas J. Hind, describing the work it accomplished. 1200 w. Eng News—July 11, 1907. No. 85570.

Reinforced Concrete.

Early Reinforced Concrete in England. Reviews what was done in England in reinforced-concrete construction before the introduction of the French systems. 2500 w. Engng—June 21, 1907. No. 85397 A.

Reinforced-Concrete Building Construction. An informal discussion before the Boston Society of Civil Engineers. 19500 w. Jour Assn of Engng Soc's—June, 1907. No. 85896 C.

Use of Reinforced Concrete in Buildings. Frank C. Schmitz. Considers the design and application of this material to the erection of buildings, discussing foundations, columns, beams and girders, stairs, floors, and walls. Ills. Discussion. 9500 w. No. 66. Pro Brooklyn Engrs' Club—1906. No. 85972 N.

Report of the Joint Committee on Reinforced Concrete. Report adopted May 27, 1907, at the general meeting of the Royal Inst. of British Architects. Rules to be observed in construction. 8500 w. Jour Roy Inst of Brit Archts—June 15, 1907. No. 85499 B.

The New Customs House at Düsseldorf (Die Neuen Zollschuppen im Düsseldorfer Hafen). D. Geiss. Illustrated description of the design and construction of this two-story, reinforced-concrete building. 2000 w. Serial. 2 parts. Deutsche Bau—June 12 and 26, 1907. No. 85640 each D.

A Reinforced-Concrete Mill Building with Separately-Molded Members. An illustrated account of the construction of several reinforced-concrete buildings at the Edison cement works by casting the members and erecting them later. 2700 w. Eng News—July 4, 1907. No. 85472.

Roads.

The Supervision of Construction of the New York State Highways. Gives the methods of procedure as described by the State Engineering Department. 3500 w. Eng Rec—July 13, 1907. No. 85546.

Sewers.

See Civil Engineering, Municipal.

Siphon.

The Building of the Siphon of Suresnes (Notice sur l'Exécution des Travaux du Siphon de Surnesnes). M. Caldaguès. A description of the construction of this steel siphon, 340 metres long, a part of the Paris scheme for the purification of the waters of the Seine. Ills. 10000 w. Ann d Ponts et Chaussées—Part I, 1907. No. 85603 E + F.

Steel Frame.

The Construction of the Seligman Building, New York. Interesting work in connection with the erection of a 11-story, fireproof, steel frame building is illustrated and described. 2500 w. Eng Rec—July 13, 1907. No. 85545.

Theatre.

The Technical Details of the Albert Schumann Theatre in Frankfurt (Die Technischen Einrichtungen des Albert Schumann-Theaters in Frankfurt). Julius Weil. Gives details of the design and construction of this unique steel structure. Ills. 1500 w. Serial. 1st part. Elektrotech u Polytech Rundschau—June 5, 1907. No. 85646 D.

Tunnel Lining.

Cost of Lining a 4000-ft. Tunnel with Concrete and in Part with Brick. Gives itemized cost of lining a single-track railway tunnel. 1500 w. Engng-Con—July 17, 1907. No. 85769.

Tunnels.

An Official Examination of the Battery Tunnel, New York. Extracts from a recent report submitted by Nelson P. Lewis.

2000 w. Eng Rec—July 13, 1907. No. 85538.

Completion of Grade Rectification in the Battery Tunnel, New York. Illustration with brief explanation of the work. 1200 w. Eng Rec—July 20, 1907. No. 85795.

Progress of the Pennsylvania Tunnels Under Manhattan Island. Illustrates and describes changes made and the progress of this great engineering work. 2000 w. R R Gaz—July 12, 1907. No. 85516.

Underpinning.

A Problem in Underpinning. Discusses the underpinning employed at Mount Royal pumping station, Baltimore. Extracts from report of Richard C. Sandlass. 1200 w. Eng Rec—July 27, 1907. No. 85945.

Warehouse.

A Concrete Warehouse with Concrete Doors and Water Tank. Illustrated detailed description of a reinforced-concrete warehouse in Kansas City, Mo. 1800 w. Eng News—July 25, 1907. No. 85885.

MATERIALS OF CONSTRUCTION.

Cement.

Simple Tests of Portland Cement. W. Purves Taylor. Gives simple tests that may be carried out by the small consumer. Tests for soundness, time of setting, purity, and strength. 1400 w. Engng-Con —July 17, 1907. No. 85770.

The Effect of Oil on Cement Mortar. R. C. Carpenter. Read before the Am. Soc. for Test Materials. A brief report of investigations. 400 w. Eng News—July 4, 1907. No. 85473.

Concrete.

The Wear of the Inter-Tidal Space On Concrete Marine Structures. Editorial discussing the possible disintegration of concrete under certain conditions. 1500 w. Eng News—July 18, 1907. No. 85738.

The Expansion of Concrete with or Without Reinforcement (Zur Frage der Dehnungsfähigkeit des Betons mit oder ohne Eiseneinlagen). C. Bach. A review of results and conclusions of elaborate tests on this subject. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—June 29, 1907. No. 85683 D.

Concrete Aggregates.

Comparative Tests of Sandstone and Slags as Concrete Aggregates. H. J. Kesner and F. W. Doolittle. Thesis. Discusses the relative merits of the different aggregates found in Denver, Colo., and vicinity. 1200 w. Min Rept—July 4, 1907. Serial. 1st part. No. 85435.

Corrosion.

See Electrical Engineering, Electro Chemistry.

Factor of Safety.

Working Stresses and Working Factor of Safety in Structures. From Prof. A. N. Talbot's résumé of Tests of Concrete and Reinforced-Concrete Columns. 1500 w. Eng News—July 11, 1907. No. 85573.

Floor Test.

Standard Test for Fireproof Floor Construction. Reported by the committee on fireproofing materials of the Am. Soc. for Test. Materials. 600 w. Eng Rec—July 6, 1907. No. 85456.

Gypsum.

Gypsum Plaster and Gypsum Products as Building Materials. Marco Pedrotti. Trans. from *Der Gips und Seine Verwendung*. Deals with the principal artificial building materials made from gypsum, and the methods of using. 2800 w. Sci Am Sup—July 13, 1907. No. 85519.

Reinforced Concrete.

Carrying Capacity of Reinforced-Concrete Floor Construction. A. E. Lindall and G. R. Heckle. Gives a record of a test on a full-sized panel. Ills. 2500 w. Eng Rec—July 20, 1907. No. 85793.

Concrete T-Beam and Column Tests at the University of Illinois. Gives a résumé of the work done and an abstract of the conclusions arrived at by Prof. Talbot. 5000 w. Eng News—July 11, 1907. No. 85572.

The Tensile Strength of Concrete in Reinforced-Concrete Beams Subjected to Bending (Beitrag zur Frage des Rechnerischen Nachweises der Betonzugspannung für auf Biegung Beanspruchte Tragwerke in Betoneisen). Fritz Postewanschitz. Gives the results of tests on reinforced-concrete beams. 3000 w. Beton u Eisen—June, 1907. No. 85657 F.

Tests of Reinforced Concrete (Eine Eisenbetonstudie). M. G. Schinke and B. Löser. Gives methods and results of tests to determine the effect of transverse stresses on reinforced concrete. Ills. 1500 w. Serial. 1st part. Beton u Eisen—June, 1907. No. 85656 F.

Reinforcement.

Tests of Cold-Twisted Steel Rods for Concrete Reinforcement. Jesse J. Shuman. Read before the Am. Soc. for Test. Mat. Information to aid in determining the quality and relative merits of concrete bars. 1200 w. Eng News—July 15, 1907. No. 85736.

Sand.

Standard Sand for Cement Work. Information from an account of investigations made by M. J. Reinhart, to ascertain the properties of the best sand and how ordinary sands can be improved. 1200 w. Eng Rec—July 20, 1907. No. 85789.

Slag.

Disposal of Slag from Smelting Works. Herbert Lang. Illustrates and describes the use of slag for the construction of a large breakwater at Santa Rosalia, Cal. 900 w. Eng & Min Jour—June 29, 1907. No. 85333.

Specifications.

The Enforcement of Specifications. Dr. Charles B. Dudley. Presidential address before the Am. Soc. for Test. Materials. Discusses materials, testing, sampling, etc. 8000 w. Eng Rec—June 29, 1907. No. 85320.

Timber.

Nomenclature and Specifications for Structural Timber. Gives the committee report presented to the Am. Soc. for Test. Materials. 1500 w. Eng Rec—June 29, 1907. No. 85325.

MEASUREMENT.

Azimuth.

A New Method for Determining Azimuth. E. H. McAlister. Explains a method which possesses advantages on the score of simplicity, in cases where only a moderate degree of precision is sought. It requires no knowledge of the time or latitude. 3500 w. Eng News—July 25, 1907. No. 85889.

Earthwork.

Earthwork Reception in Egypt. Describes methods of swindling in the measurement of earthwork, dealing with various classes of work. 2800 w. Engr, Lond—June 21, 1907. No. 85402 A.

Impact Test.

A New Impact Test. L. W. Page. Read before the Am. Soc. for Test. Materials. Illustrates and describes a machine for such tests. The main object being to determine the relative toughness of road-building rocks. 1500 w. Eng Rec—July 6, 1907. No. 85459.

Stream Discharge.

A Method of Estimating Stream Discharge from a Limited Number of Gagings. J. C. Stevens. Describes a method extensively used in the Columbia River District. 1000 w. Eng News—July 18, 1907. No. 85732.

Surveying.

City Surveying in Its Relation to Judicial Functions and Actual Practice. I. Judicial Functions of the City Surveyor. Lewis T. Haney. II. Practice of City Surveyors in the City og New York. Richard L. Williams. Discussion. 6200 w. No. 70. Pro Brooklyn Engrs' Club—1906. No. 85976 N.

The Topographical Survey of Staten Island. Describes methods used in surveying this borough of New York City. 2500 w. Eng Rec—July 20, 1907. No. 85796.

Terrestrial Magnetism.

Recent Results of Terrestrial Magnetic Observations. L. A. Bauer. A review of general progress, with an outline of the work of magnetic survey of the United States and contiguous territory. 7000 w. Tech Qr—June, 1907. No. 85718 E.

Volumes.

Determining Volumes of Coal in Bins and Piles. Charles Enzian. Gives methods and formulæ for finding the dimensions of masses of different forms either intact or partly tapped. 1700 w. Eng & Min Jour—July 27, 1907. No. 85955.

Water Level.

A Pictorial Appeal;—Water-Works Too. H. F. Dunham. Showing simple methods of making an accurate automatic record of the elevation of water, uninfluenced by wave action, for determining the changes in level of the Great Lakes. 3800 w. Pro Am Water-Wks Assn—1906. No. 85803 N.

Water Meters.

Simplex Water Meter. J. W. Ledoux. Describes the development of design and application of this meter to the flow of water through pipes. Ills. 1500 w. Pro Am Water-Wks Assn—1906. No. 85811 N.

MUNICIPAL.

Garbage Disposal.

The Importance of Garbage Burning from an Electrical Point of View (Die Bedeutung der Müllverbrennung für die Elektrotechnik). G. Dettmar. A discussion of the possibility of developing electric power from the burning of city refuse, the first part discussing the average composition of garbage. 2500 w. Serial. 1st part. Elektrotech Zeitschr—June 27, 1907. No. 85688 D.

Gary, Ind.

The Municipal Works of Gary, Ind. Describes the extensive municipal improvements and public service system at this city which is being built in connection with the new plant of the United States Steel Corporation. Ills. 5700 w. Eng Rec—July 20, 1907. No. 85788.

Kyoto, Japan.

Municipal Engineering Works of Kyoto, Japan. S. Tanabe. Brief account of a new aqueduct and hydro-electric power plant; the Kyoto water supply; and city tramway. Ills. 500 w. Eng News—July 4, 1907. No. 85471.

Pavements.

Recent Progress in the Asphalt Paving Industry. Clifford Richardson. Read before the N. Y. Sec. of the Soc. of Chem. Ind. Briefly describes this industry in its early periods, and reviews the advances recently made. 3000 w. Engng-Con—June 26, 1907. Serial. 1st part. No. 85337.

Road Hardening.

The Soil of Our Roads and Streets (Le Sol de nos Routes et de nos Rues). G. Espitallier. An account of experiences in France in hardening and reducing dust on roads by surface applications, illustrating and describing methods and machines employed. 5500 w. Bull Soc d'Encour—May, 1907. No. 85609 G.

Roads.

See Civil Engineering, Construction.

Sewage.

The Determination of the Organic Nitrogen in Sewage by the Kjeldahl Process. Leyland Whipple. Presents results of experiments carried out on direct reading of Kjeldahl digestates, giving a procedure that has been found successful. 2200 w. Tech Qr—June, 1907. No. 85717 E.

Sewage Disposal.

Electricity in the Hanley Sewage Works. The method of driving the sewage distributors is illustrated and described, and the lighting of the works. 2200 w. Elec Engr, Lond—June 21, 1907. No. 85380 A.

Sewage Disposal bv Dilution. George C. Whipple. Considers the subject from the viewpoint of the public health, and also from the viewpoint of nuisance. Discussion. 10000 w. No. 71. Pro Brooklyn Engrs' Club—1906. No. 85977 N.

Sewer.

Large Riveted Steel Sewers in Jersey City, N. J. Illustrates and describes an 8-ft. storm-water sewer under construction to serve the thickly settled Hudson City section. 1600 w. Eng Rec—July 13, 1907. No. 85544.

WATER SUPPLY.

Boston.

Metropolitan Water Works. Dexter Brackett. An illustrated detailed description of these extensive works, which will supply nineteen municipalities within the present district. 10000 w. Pro Am Water Wks Assn—1906. No. 85817 N.

Copper Sulphate.

Copper Sulphate Results. James M. Caird. Presents results of treatment for algæ growths and bacteria by copper sulphate. 3300 w. Pro Am Water Wks Assn—1906. No. 85805 N.

Dams.

The Upper Grays Dam, Consolidated Water Co., Utica, N. Y. Illustrates and describes a dam built under unusual conditions as to foundations, and unusual requirements as to future extension. 600 w. Eng Rec—July 20, 1907. No. 85704.

Cheesman Dam. George T. Prince. Illustrates and describes the engineering features of this granite dam on the South Fork of the South Platte River. It has a height sufficient to store a depth of 212 feet of water and was constructed for the supply of the City of Denver. 3300 w. Pro Am Water Wks Assn—1906. No. 85816 N.

The Metropolitan Water Works System of Massachusetts. Caleb Mills Saville. Brief illustrated description of the construction of the Wachusett dam on the Nashua River, at Clinton. 1800 w. Munic Engng—July, 1907. No. 85715 C.

Expansion.

Expanding Water Supply Systems. J. T. Fanning. Discusses the losses due to undue expansion of the pipe lines, and the remedy. General discussion. 2500 w. Pro Am Water Wks Assn—1906. No. 85808 N.

Filtration.

Filtration of Water. F. A. W. Davis. Illustrated detailed description of the slow sand filtration plant of the Indianapolis Water Co., with tabulated summary of results. 2500 w. Pro Am Water Wks Assn—1906. No. 85797 N.

Hackensack, N. J.

Increasing the Capacity of the Hackensack Water Company's System by Introducing a Relay Pumping Station, as Compared with Cost of Building a New Force Main. D. W. French. An illustrated article, with map, explaining conditions and describing the plant at New Durham. Also gives the official test of the 12-million gallon Allis engine located at this station. 3000 w. Pro Am Water Wks Assn—1906. No. 85807 N.

High Pressure.

High Pressure Water Systems. F. L. Hand. An illustrated description of the Philadelphia high pressure fire service, giving estimates of first cost and cost of operation and maintenance. 10000 w. Pro Am Water Wks Assn—1906. No. 85815 N.

Proposed Auxiliary High Pressure Fire Protection Water Supply for Hartford, Conn. Particulars from an interesting report recently submitted to the Common Council. 800 w. Eng News—July 18, 1907. No. 85733.

Irrigation.

Proposed Irrigation System of the Wyoming Central Irrigation Co. for the Ceded Portion of the Shoshone or Wind River Indian Reservation. H. G. Raschbacher. An account of the surveys made and specifications agreed upon. Ills. 4500 w. Purdeu Engng Rev—1907. No. 85,930 N.

Irrigation in India. C. O. Burge. Deals particularly with the work in the Punjab and Scinde 3000 w. Eng Rec—June 29, 1907. No. 85326.

Mains.

Extension and Improvements in the Supply Main, Yarmouth, N. S. George H. Robertson. An illustrated article giving a short description of the gate house, intake pipes and supply main, and methods used for extension and cleaning. 600 w. Pro Am Water Wks Assn—1906. No. 85801 N.

Meters.

Some New Facts Relating to the Effect

of Meters on the Consumption of Water. William S. Johnson. Gives information on the use and waste of water, discussing why results expected from metering were not realized. General discussion. 17000 w. Jour N Eng Water Wks Assn—June, 1907. No. 85897 F.

See Civil Engineering, Measurement.

Milwaukee, Wis.

The Kinnickinnic River Flushing Tunnel and Pumping Station, Milwaukee, Wis. Illustrates and describes methods adopted to overcome troubles from river pollution. 2000 w. Eng Rec—July 27, 1907. No. 85944.

Modling, Austria.

The Water Works System of Mödling (Das Wasserwerk der Stadt Mödling). Paul Frenz. Describes the hydro-electric power station, pumping plant, pipe lines and reservoir of the water system of this Austrian town. Ills. 3000 w. Elektrotech u Maschinenbau—June 9, 1907. No. 85659 D.

New York City.

Inauguration of Work on the Catskill New York Water Supply. Map of the proposed system with brief account of inauguration of this gigantic enterprise. 1500 w. Sci Am—June 29, 1907. No. 85314.

Pollution.

River Pollution. Marshall O. Leighton. A discussion of its present status and suggestions concerning remedial policy. Discussion. 6500 w. Pro Am Water Wks Assn—1906. No. 85799 N.

A Judicial Review of American Stream Pollution Decisions. A review recently written by Judge Hainer of the Oklahoma Supreme Court. 4500 w. Eng Rec—June 29, 1907. No. 85323.

Pumping Engines.

See Mechanical Engineering, Steam Engineering.

Pumping Stations.

The Growth of the Pumping Station. Charles A. Hague. Reviews the development, especially during the last twenty years, the types, and the future outlook. Discussion. 9600 w. Pro Am Water Wks Assn—1906. No. 85809 N.

Purification.

Disinfection as a Means of Water Purification. George C. Whipple. Describes water-works at Ostende and Middelkerke, Belgium, where chlorine is used as a disinfecting adjunct to filtration. Gives list of articles on the manufacture and application of ozone. Discussion. 6800 w. Pro Am Water Wks Assn—1906. No. 85806 N.

Notes on Sewage Purification and Public Water Supplies. M. N. Baker. Outlines some of the available methods of sewage treatment, giving definitions of processes, and a bibliography. Discussion. 3500 w. Pro Am Water Wks Assn—1906. No. 85798 N.

Notes on Water Purification at St. Louis. W. F. Monfort. Abstract of a paper read before the Am. Water-Wks. Assn. A brief statement of chemical and bacterial results for the past year at one of the larger plants using lime and iron sulphate as coagulants, without the use of filters. 2500 w. Eng Rec—July 27, 1907. No. 85947.

Reservoir.

The Barren Jack Reservoir, New South Wales. Gives a general outline of the Barren Jack irrigation scheme, and describes the design of the dam and weir. 3000 w. Engng—July 5, 1907. No. 85589 A.

Siphon.

See Civil Engineering, Construction.

Softening.

Water Softening for Municipal Supplies. George W. Fuller. Considers some of the more important features upon which the treatment depends, and illustrates typical works. Discussion. 8500 w. Pro Am Water Wks Assn—1906. No. 85802 N.

St. Catharines, Ont.

St. Catharines' Waterworks. An illustrated historical account of this supply, stating the advantages secured through agreement with the Hamilton Cataract Power Company. 1500 w. Can Engr—July 5, 1907. No. 85407.

St. Louis.

The New Settling Basins and Other Improvements to the St. Louis, Mo., Water Supply System. Additions and extensions including two new settling basins, a 7-ft. steel pipe flow line, and a storage reservoir are illustrated and described. 5500 w. Eng Rec—July 6, 1907. No. 85458.

The Chicago Drainage Canal Case. William P. Mason. A brief historical sketch of the suit brought by the city of St. Louis to stop the diversion of Chicago sewage into the Mississippi valley. Introductory to abstracts of testimony by John W. Hill, Robert Spurr Weston, T. J. Burrill, Gardner S. Williams, Edwin O. Jordan, Leonard P. Kennicutt, Rudolph Herring, George W. Fuller, Allen Hazen, and others. 2500 w. Pro Am Water Wks Assn—1906. No. 85804 N.

Typhoid.

The Rôle of Public Water Supplies in the Spread of Typhoid Fever as Shown Chiefly by the Greatest Typhoid Epidemics. George A. Soper. Considers some of the ways in which water supplies become contaminated and how extensive the results may become. Discussion. 8500 w. Pro Am Water Wks Assn—1906. No. 85800 N.

Official Report on Typhoid Fever in Washington, D. C., in 1906. Information from this comprehensive report, with editorial comment. 6500 w. Eng News—July 11, 1907. No. 85577.

Valuation.

A Retrospect of an Arbitration on the Value of a Water Works. Albert H. Wehr. Gives a statement of the method of value appraisal in the case with the City of Baltimore. Discussion. 8000 w. Pro Am Water Wks Assn—1906. No. 85813 N.

Waste.

The Photo-Pitometer and Water Works Losses. Edward S. Cole. Considers the waste of water and means for its control, and the use of the photo-pitometer for measuring the flow. Illustrates and describes the instrument. 4500 w. Tech Qr—June, 1907. No. 85716 E.

WATERWAYS AND HARBORS.

Bahia Blanca.

The Port of Bahia Blanca (El Puerto de Bahia Blanca). Alejandro Foster. A description of this important harbor in the Argentine Republic. Ills. 5500 w. Ingenieria—May 15, 1907. No. 85620 D.

Canals.

The Harvey Canal and Lock. Gervais Lombard. Gives an interesting review of the history of this canal in Louisiana, with a report of recent work, the difficulties and methods of overcoming them. Ills. 4000 w. Jour Assn of Engng Soc's—June, 1907. No. 85895 C.

See also Civil Engineering, Bridges.

Coal Tip.

New Ferro-Concrete Jetty and Coal Tip at Port Talbot. An illustrated description of a new high-level coal tip, and the ferro-concrete jetty. 2000 w. Col Guard —July 19, 1907. No. 85990 A.

Colorado River.

Closing the Colorado River Crevasse. H. T. Cory. A brief review of this difficult and important engineering work. 4000 w. Purdue Engng Rev—1907. No. 85943 N.

The Diversion of the Colorado River into the Salton Sink and the Efforts Made to Restore it to Its Former Channel. J. A. Ockerson. An illustrated account of this disaster and the various attempts made to turn the river back to its channel, and the final success. 3500 w. Jour Assn of Engng Soc's—June, 1907. No. 85894 C.

Concrete Structures.

See Civil Engineering, Materials of Construction.

Dam.

Method of Constructing the Crockers Reef Dam, New York Barge Canal, Near Fort Edward, N. Y. Lindon Bates, Jr. Describes the first dam of the New York Barge Canal. It is mainly of second-class concrete, requiring about 3550 cu. yds. Ills. 1200 w. Engng-Con—July 10, 1907. No. 85563.

Docks.

Avonmouth Docks. Gives illustrations and information of progress in the construction of the Royal Edward Dock and entrance lock. 900 w. Engr, Lond—July 5, 1907. No. 85595 A.

The New Cardiff Dock. Gives the general plan of the Bute Docks, with remarks on their growth, and a detailed description of the new South Dock. Ills. 4800 w. Engr, Lond—July 12, 1907. No. 85875 A.

Ferry Terminal.

The Staten Island Ferry Terminal. Illustrated detailed description of the terminal facilities provided for the municipal ferry between Battery Park and St. George. 3000 w. Eng Rec—June 29, 1907. No. 85322.

Galveston, Tex.

See Civil Engineering, Construction.

Mannheim, Germany.

The Commercial Harbor at Mannheim (Der Industriehafen zu Mannheim). Herr Eisenlohr. Illustrated description of the harbor works at this important shipping point on the Rhine in Germany with details of the commerce handled. 3500 w. Serial. 2 parts. Deutsche Bau—June 8 and 15, 1907. No. 85639 each D.

Panama Dams.

The Isthmian Canal Dams in the Light of the Wachusetts Dam Landslip. Lindon W. Bates. Describes the slip occurring April 11, on the north dike of the Wachusett reservoir, and compares the design for the Gatun dam for the Panama Canal. Ills. 3500 w. Engng-Con—July 17, 1907. No. 85772.

Water Level.

See Civil Engineering, Measurement.

MISCELLANY.

Arches.

Empirical Design of Reinforced Arches. Daniel B. Luten. Brief explanation of an empirical method based on the elastic theory devised by the writer. Ills. 1000 w. Purdue Engng Rev—1907. No. 85942 N.

The Symmetrical Masonry Arch; Analysis According to the Elastic Theory. Malverd A. Howe. An explanation of a method of determining the safety. 1200 w. R R Gaz—July 26, 1907. No. 85903.

Beams.

Diagrams for the Design of Reinforced Concrete Beams. Gives diagrams drawn by F. Teichman, with statement of their make-up and use. 2500 w. Eng News—July 11, 1907. No. 85571.

The Calculation of the Stresses in a Fixed Rod Subjected to both Compression and Bending (Der Eingespannte, auf

Druck und Biegung beanspruchte Stab). Ivan Arnovlevic. Mathematical paper with diagrams and tables. 10000 w. Oesterr Wochenschr f d Oeffent Bau—June 1, 1907. No. 85673 D.

Lettering.

An Improved System of Lettering Maps and Drawings. Henri V. Lemenager. A brief description of a system of type-printed lettering, which has been in successful use in the drafting section of the Reclamation Service. 900 w. Eng News—July 18, 1907. No. 85737.

Reclamation.

Work of the United States Reclamation Service. F. H. Newell. Explains the provisions of the Reclamation Act and gives an illustrated account of the work in progress. 3500 w. Jour Fr Inst—July, 1907. No. 85702 D.

Rib Beams.

Calculation of Reinforced-Concrete Rib Beams of the Lowest and Most Favorable Height (Berechnung der Rippenbalken aus Eisenbeton von Niedrigster und Vorteilhaftester Höhe). Prof. Ramisch. Mathematical paper. 2000 w. Serial. 1st part. Elektrotech u Polytech Rundschau —June 26, 1907. No. 85647 D.

Wind Stresses.

Wind Reactions in Mill-Building Frames. C. H. Wood. Aims to put the formulæ of Prof. Sondericker in such simple shape that they can be more easily applied in practical design. 900 w. Eng News—July 18, 1907. No. 85735.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radiotelegraphy.

Wireless Telegraphy—Some of Its Practical and Commercial Aspects. William Maver, Jr. Read at the convention of the Assn. of Ry. Tel. Supts. The present service of wireless telegraphy, recent improvements, and the limitations of the system are discussed. 3000 w. Elec Rev, N Y—July 13, 1907. No. 85534.

Wireless Telegraphy: A Solution of the Problem of Selectivity. I. Hettinger. Abstract of a specification of a British patent recently granted the writer for a method of selective wireless telegraphy wherein the selectivity is secured independently of the magnitude of the power and distance of transmission of the interfering station. 2000 w. Elec Engr, Lond—June 21, 1907. No. 85381 A.

Spark Telegraphy (Die Funkentelegraphie). A. Linker. A review of the theory and development of radiotelegraphy, discussing the work of the leading investigators. Ills. 3000 w. Serial. 2 parts. Eisenbahntech Zeitschr—June 12 and 26, 1907. No. 85665 each D.

Telegraph Poles.

Experiments with Concrete Telegraph Poles. G. A. Cellar. Gives results of tests made by the Pennsylvania Lines west of Pittsburg. Ills. 700 w. Elec Wld—June 29, 1907. No. 85350.

Telegraphy.

Central-Battery Telegraphs. A brief illustrated description of the British post-office arrangements as applied to duplex and omnibus circuits. 1200 w. Elec Rev, Lond—June 28, 1907. No. 85496 A.

Examination of Telegraphers for Railroad Work. H. C. Hope. Read before the Ry. Tel. Supts.' Assn. An account of the required examination. 1500 w. R R Gaz—July 5, 1907. No. 85466.

Inductive Disturbances to Telegraph Lines. John B. Taylor. Read before the Assn. of Ry. Tel. Supts. Discusses factors affecting induction in telegraph lines and the elimination of disturbance. 3000 w. Ry Age—July 12, 1907. No. 85556.

Telemechanic.

The Branly "Telemechanic" System. C. L. Durand. Prof. Branly's system, of operating mechanical devices from a distant point, is illustrated and described. 2500 w. Elec Rev, N Y—July 27, 1907. No. 85950.

Telephone Cables.

Aerial Cable Construction for Telephone Exchanges. C. W. Burkett. An illustrated article discussing the practical and technical details. 3500 w. Cassier's Mag—July, 1907. No. 85711 B.

Telephony.

Magneto Generators. L. J. Flint. Considers the magneto generator used in local battery telephones, explaining a few of the reactions and favoring the rigid field end shaft construction. 2000 w. Purdue Engng Rev—1907. No. 85931 N.

Wireless Telephone.

How to Construct a Simple Wireless Telephone. A. Frederick Collins. Illustrates and describes a construction that will give results up to 30 or 40 feet and operate through ordinary walls. An application of electro-magnetic induction. 2000 w. Sci Am Sup—July 20, 1907. No. 85742.

DISTRIBUTION.

Conductors.

The Heating of Copper Wires by Electric Currents. A. E. Kennelly and E. R.

Shepard. A report of research work in the measurement of temperature elevation of electric cables so far as relates to wires in water, soil, or wooden moulding. 5000 w. Pro Am Inst of Elec Engrs—June, 1907. No. 85752 D.

Power Factor, Alternating-Current Inductive Capacity, Chemical and Other Tests of Rubber-Covered Wires of Different Manufacturers. Henry W. Fisher. Gives results of tests made, one of the objects being to see if power-factor tests would not give an insight into the qualities of different makes of rubber-insulated wires. 3000 w. Pro Am Inst of Elec Engrs—June, 1907. No. 85754 D.

Rectifiers.

Tests of a Mercury Current Rectifier (Untersuchung eines Quecksilbergleichrichters). Dr. Josef Polak. Describes the apparatus, which was of the ordinary type produced by the General Electric Company, and gives the results of tests with curves and tables. Ills. 2000 w. Elektrotech u Maschinenbau—June 2, 1907. No. 85658 D.

Tests on a Mercury-Vapor Rectifier. Brief account of tests carried out by J. Polak, as described in a recent number of *Elektrotechnik und Maschinenbau.* Diagrams. 700 w. Elec Engr, Lond—July 12, 1907. No. 85861 A.

Rotary Converters.

Heating Effect of Quadrature Currents in Rotary Converters. J. H. Hunt. Gives a mathematical comparison of the heating effect in rotary converters and in synchronous motors or alternating-current generators. 800 w. Elec Wld—July 27, 1907. No. 85958.

Sub-Stations.

Sub-Station Equipment and Operation, Chicago Edison Company and Commonwealth Electric Company. R. G. Grant. Describes the equipment of a standard sub-station, tracing the current from the transmission line to the center of distribution. 3000 w. Elec Wld—July 27, 1907. No. 85959.

The Rotary Converter Sub-Station. R. F. Schuchardt. Describes the essential constructional details of these stations and the manner of operating them in Chicago. General discussion. Ills. 7800 w. Jour W Soc of Engrs—June 1, 1907. No. 85725 D.

Wiring.

Wiring Plans for Heating Appliances. F. M. Feiker. Gives suggestions for wiring houses costing $5000 to $7000. Ills. 1000 w. Elec Rev, N Y—July 13, 1907. No. 85533.

DYNAMOS AND MOTORS.

Insulation.

The Selection of Machine Insulation Material. William S. Conant. Discusses materials intended for the insulation of electric machinery, methods of testing them, and the effects of certain ingredients. 3000 w. Elec Wld—July 20, 1907. No. 85847.

Single-Phase.

The New Double-Circuit Single-Phase Motor of the Felten & Guilleaume-Lahmeyer Works. M. Osnos. Abstract from the *Elektrotechnische Zeitschrift.* In the present article this motor is considered as a lift motor, showing how it fulfils the requirements. 1500 w. Elect'n, Lond—July 12, 1907. No. 85865 A.

Synchronous.

Interaction of Synchronous Machines. Morgan Brooks. Presents a new circle diagram showing the physical relation of the quantities and conditions involved, deriving fundamental equations, and developing simple loci for solving the problems of synchronous operation. 5000 w. Pro Am Inst of Elec Engrs—June, 1907. No. 85753 D.

Three-Wire.

Three-Wire Dynamos. Illustrates and describes various types of three-wire dynamos. 1800 w. Elec Wld—July 20, 1907. No. 85850.

Variable Speed.

A New Variable Speed Electric Motor or Variable Voltage Dynamo. Dr. L. Torda. An illustrated description of a variable speed motor or a variable voltage generator with reluctance control which has been devised by the author. 2500 w. Elect'n, Lond—July 5, 1907. No. 85583 A.

ELECTRO-CHEMISTRY.

Calcium Cyanamide.

The Calcium Cyanamide Industry (Sull Industria della Calciocianamide). A review of the history of this industry, outlining the process of manufacture and giving costs. 2200 w. Industria—June 2, 1907. No. 85623 D.

Carbon Tetrachloride.

Manufacture and Uses of Carbon Tetrachloride. J. R. Crocker. Gives information in regard to carbon tetrachloride and illustrates and describes apparatus for its production. 3300 w. Elec-Chem & Met Ind—July, 1907. No. 85487 C.

Corrosion.

The Effect of Stress Upon Corrosion of Iron. Prof. William H. Walker and Mr. Colby Dill. Abstract of a paper describing investigations and results. Also abstract of paper by Dr. A. S. Cushman offering a new electrolytic theory of the corrosion of iron, and editorial. 4500 w. Elec-Chem & Met Ind—July, 1907. No. 85488 C.

Detinning.

Electric Detinning of Tinplate Scrap.

G. Crudo. Compiled from *Rassegna Mineraria.* Information concerning the author's work in this field, describing processes and examining the economic conditions. 1500 w. Min Jour—July 13, 1907. No. 85868 A.

Electrometallurgy.

The Electric Furnace in Steel Making and Copper Smelting. T. Scott Anderson. Considers the application of the electric furnace to ore reduction, describing the author's patents. 1500 w. Eng & Min Jour—June 29, 1907. No. 85331.

Electroplating.

Sheffield Plate and Electro-Plate. Sherard Cowper-Coles. Gives historical sketches of Sheffield plate and electro-plate, describing methods, testing, etc. Ills. 6000 w. Jour Soc of Arts—July 12, 1907. Serial. 1st part. No. 85851 A.

Electro-Deposition of Brass. Charles H. Proctor. Read before the Am. Found. Assn. Suggestions on the electro-deposition of brass upon baser metals. 1000 w. Foundry—July, 1907. No. 85750.

Nitrogen.

The Electro-Thermic Combustion of Atmospheric Nitrogen. F. Howles. Read before the Soc. of Chem. Ind. Discusses the factors involved and gives a general summary of what has been accomplished. 4800 w. Elect'n, Lond—July 19, 1907. No. 85985 A.

ELECTRO-PHYSICS.

Dielectrics.

Physical Characteristics of Dielectrics. A. P. M. Fleming. A study of the effects produced by electrostatic stresses in gases, liquids, and solids. 2500 w. Elec Jour—July, 1907. No. 85706.

Insulation.

Face of Insulating Materials Under Oil. J. W. Esterline, J. R. Clark, J. E. Breese. Illustrated report of a series of investigations. 1000 w. Purdue Engng Rev—1907. No. 85941 N.

Oscillatory Discharge.

The Oscillatory Discharge in Iron Wires. A. Battelli and L. Magri. Translated from *Physikalische Zeit.* Gives results of investigations. 2200 w. Elect'n, Lond—July 12, 1907. No. 85866 A.

Vibrations.

The Superposition of Mechanical Vibrations (Electric Oscillations) upon Magnetization, and Conversely, in Iron, Steel and Nickel. James Russell. An account of investigations on the subject. 3300 w. Elect'n, Lond—July 5, 1907. No. 85585 A.

GENERATING STATIONS.

Alternators.

Compounded Alternators with Commutators. A. Heyland. Describes practical experiences with some large compounded alternators which have been running several years. Ills. 1500 w. Elect'n, Lond—July 19, 1907. No. 85987 A.

Balancers.

Balancers versus Three-Wire Dynamos. Budd Frankenfield. Read before the Nat. Elec. Lgt. Assn. An interesting discussion of the advantages of the balancer for three-wire lighting sets. 4500 w. Elec Rev, N Y—July 13, 1907. No. 85536.

Costs.

The Costs of Electricity Supply and Their Relation to Scales of Charges. H. R. Burnett. Read before the Incor. Munic. Elec. Assn. Describes the method adopted by the writer for ascertaining the costs of supply and the manner of applying the information in fixing the scale of charges. 3500 w. Elec Engr, Lond—July 5, 1907. No. 85580 A.

Cheap Power Supply by Municipalities. C. E. S. Shawfield. Discusses some of the general principles involved in the problem of cheap power supply. 3000 w. Elec Engr, Lond—June 28, 1907. No. 85495 A.

Depreciation.

See Industrial Economy.

Generating Sets.

Upkeep Charges on Large Electric Generating Sets. Henry Robert John Burstall and John Somerville Highfield. Read at Engng. Con. of the Inst. of Civ. Engrs. Aims to draw out information as to the differences which may exist in the charges necessary to cover repairs and maintenance. Discussion. 1800 w. Elec Engr, Lond—June 21, 1907. No. 85384 A.

Hydro-Electric.

Hydraulic Development at West Buxton, Me. Illustrated description of a hydraulic plant on the Saco River involving the construction of a dam, a power house, a dynamo house, a boom, a log-chute, and a tail race. Current to be transmitted to Portland. 2200 w. Eng Rec—July 27, 1907. No. 85948.

Method of Construction of the Water Power Plant on the Chicago Drainage Canal. LeRoy K. Sherman. Illustrated description of this hydro-electric development of 36000 h.p. now nearing completion. 1500 w. Engng-Con—July 3, 1907. No. 85438.

Novel Features of the Huronian Company's Water Power Development. High Falls, Ontario. Brief illustrated description of the dams and constructional features. 1500 w. Eng News—July 18, 1907. No. 85731.

The Hydro-Electric Plant of the Vancouver Power Co. Detailed description of a plant supplying power for electric lighting, street railways, and commercial purposes in Vancouver, B. C., and surrounding towns. 2500 w. Eng Rec—July 13, 1907. No. 85542.

The Hydro-Electric Power Development of the M'Call Ferry Power Co. H. T. Herrick. Brief illustrated account of the construction of this dam on the Susquehanna River, and the power plant. 1000 w. Purdue Engng Rev—1907. No. 85936 N.

The Nine-Mile Power Station of the Spokane & Inland Empire Railway. H. Cole Estep. Illustrations, with description of the method of construction, and the design. 1200 w. Eng Rec—July 20, 1907. No. 85792.

The Taylor's Falls, Minn., Water-Power Development. An illustrated detailed description of an important water power development on the St. Croix River, which supplies current for lighting and power to Minneapolis and surrounding districts. 2500 w. Eng Rec—June 29, 1907. Serial. 1st part. No. 85319.

The Power Plant on the Sill at Innsbruck (Die Sillwerke bei Innsbruck). An illustrated description of this important hydro-electric power plant in the Tyrol which supplies electrical energy for lighting and power purposes in Innsbruck and also for the operation of the Stubai Valley Railway. 2000 w. Serial. 1st part. Der Elektrotechniker—June 10, 1907. No. 85649 D.

The Electrical Plants on the Traun and in St. Wolfgang (Das Traunfallwerk und die Elektrizitätswerke in St. Wolfgang). Illustrated detailed description of these power stations and transmission systems in Austria. 2500 w. Elektrotech u Maschinenbau—June 30, 1907. No. 85663 D.

Municipal.

The Municipal Electric Plant at The Hague (De Gemeentelijke Electriciteitsfabriek te 's-Gravenhage). N. J. Singels. An illustrated description of the design and equipment of this large municipal generating station with details of operation and costs. 4500 w. De Ingenieur—June 1, 1907. No. 85689 D.

New Machinery.

New Electric Machines and Appliances (Neuere Elektrische Maschinen und Geräte). K. Meyer. Illustrates and describes recent types of machinery developed by the Siemens-Schuckert Company, including armatures, turbo-dynamos, transformers, switches, etc. 6000 w. Zeitschr d Ver Deutscher Ing—June 1, 1907. No. 85676 D.

Oiling System.

An Oiling System in a Large Power Plant. Plan and description of the lubricating-oil circulating system in the Long Island City power station of the Pennsylvania R. R. 700 w. Elec Age—July, 1907. No. 85837.

Parallel Operation.

Reactions Between Compound-Wound Generators Operating in Parallel. Clarence A. Boddie. An explanation of how and why the machines are mutually adjusting. 2400 w. Power—July, 1907. No. 85344 C.

Plant Equipment.

Effect of Power Factor on Plant Equipment. Prof. J. H. Dobson. Shows that by proper plant equipment the efficiency of running can be increased; and the transformer, distributing and generator losses considerably reduced and capital expenditure saved—May, 1907. No. 85377 F.

Power Plants.

Cleveland Arcade Electrical Plant. A recently completed plant for office building purposes, containing unusual features, is illustrated and described. 3000 w. Elec Wld—July 20, 1907. No. 85846.

Equipment for the Pacific Light & Power Co.'s Plant. Illustrates and describes horizontal vertical-compound engines with surface condensers, driving alternating-current generators. 2500 w. Engr, U S A—July 1, 1907. No. 85371 C.

Electrical Equipment of the Hall of Records in Manhattan Borough, New York City. Illustrated detailed description of the power plant, distribution of circuits, and features of illumination. 3000 w. Elec Wld—July 27, 1907. No. 85957.

The Stratford Power Station of the Great Eastern Railway. Illustrated description of this modern turbo-generating plant. 2500 w. Elec Rev, Lond—July 12, 1907. No. 85863 A.

Switchboards.

Switchboard Practice for Voltages of 60000 and Upwards. Stephen Q. Hayes. Discusses the chief points of interest in connection with high-voltage switchboard practice. Ills. 5500 w. Pro Am Inst of Elec Engrs—June, 1907. No. 85761 D.

Switchgear.

Central Station Switchgear, Etc. Arthur Imbery. Considers direct-current switchgear, etc., as used in central stations, supplying electrical energy for lighting, power and tramway purposes. Ills. 1200 w. Elec Engr, Lond—July 12, 1907. No. 85860 A.

Tasmania.

Launceston, Tasmania. An illustrated report on the electricity works by William Corin, giving a résumé of progress, and an idea of the probable extensions. 4500 w. Elec Engr, Lond—July 5, 1907. No. 85581 A.

Turbo-Generator.

Tests and Operating Results on the 5500-KW Turbo-Generator of the Interborough Rapid Transit Company. Gives tables and diagram showing the results of tests. 800 w. Elec Jour—July, 1907. No. 85708.

LIGHTING.

Arc Lamps.

Arc Lamps for Railway Car Illumination; Their Distribution and Characteristics. Alfred L. Eustace. A system recently installed in a car on the Chicago & Northwestern Railway is illustrated and described. It is on trial service between Chicago and Waukegan. 2200 w. Elec Wld—July 13, 1907. No. 85564.

Enclosed Arc Lamps. W. Wedding. Abstract translation from *Elektrische Kraftbetriebe u. Bahnen.* Describes tests and gives results. 1800 w. Elect'n, Lond—June 21, 1907. No. 85389 A.

Illumination.

Illumination and Some Illuminants. J. D. Mackenzie. Abstract of paper read before the Glasgow Sec. of the Inst. of Elec. Engrs. Discusses necessary qualifications for successful illumination and how they may be attained in practice. 2000 w. Elect'n, Lond—June 21, 1907. No. 85390 A.

Recent Advances in Artificial Lighting. Information of new incandescent lamps recently put on the market, with illustrations. Also recent advances in gas lighting. 7500 w. Eng News—July 25, 1907. No. 85890.

The Fundamental Principle of Artificial Illumination. Editorial on the principles governing safe and useful applications ot light. 3500 w. Eng News—July 25, 1907. No. 85891.

Incandescent Lamps.

The Improvement of the Incandescent Lamp. R. Milward Ellis. Considers the improvement of the carbon filament, and other filaments for incandescent lamps. 2500 w. Elec Engr, Lond—July 19, 1907. Serial. 1st part. No. 85984 A.

Modern Incandescent Lamps (Modernas Lámparas Eléctricas de Incandescencia). Sancho López López. The first part of the serial deals with the osminum lamp. Ills. Serial. 1st part. 4000 w. Energia Elec—June 10, 1907. No. 85619 D.

Mercury Arcs.

Tests of a Mercury Arc Lamp. A. N. Topping. Brief description of the main points in these lamps, with account of tests. Ills. 3000 w. Purdue Engng Rev—1907. No. 85940 N.

The Mercury Arc and Its Technical Applications (Der Quecksilber-Lichtbogen und seine Technische Verwendung). Josef Polak. The first part of the serial discusses the physical principles on which the mercury vapor lamp is constructed. Ills. 4500 w. Serial. 1st part. Elektrotech Zeitschr—June 13, 1907. No. 85686 D.

Photometry.

See Electrical Engineering, Measurement.

Street Lighting.

Suggested Specifications for Street Lighting. Report to the National Electric Light Association by a committee, with editorial comment unfavorable to the adoption of the specifications. 3200 w. Eng Rec—July 20, 1907. No. 85791.

MEASUREMENT.

Cymometer.

The Fleming Direct-Reading Cymometer. A Frederick Collins. Illustrated description of an instrument for measuring wireless telegraph waves. 1500 w. Sci Am Sup—July 27, 1907. No. 85893.

Dielectrics.

On the Loss of Energy in the Dielectric of Condensers and Cables. Dr. Bruno Monasch. Gives a method of measuring dielectric losses and discusses the sources of error to be avoided. 3000 w. Elect'n, Lond—June 28, 1907. Serial. 1st part. No. 85497 A.

Hysteresis.

On a Method of Plotting the Hysteresis Loop for Iron with an Application to a Transformer. Dr. Gisbert Kapp. Describes test. 700 w. Elect'n, Lond—July 12, 1907. No. 85867 A.

Iron Losses.

The Separation of the Iron Losses in Asynchronous Machines. Thomas F. Wall. Shows how these losses may be separated without the use of retardation curves, and the results of experiments on a 5 h.p. motor. 2500 w. Elect'n, Lond—June 21, 1907. No. 85388 A.

Light Units.

A Comparison of the Unit of Luminous Intensity of the United States with Those of Germany, England, and France. Edward P. Hyde. Abstracted from the *Bulletin* of the Bureau of Standards. 2500 w. Elect'n, Lond—July 19, 1907. No. 85988 A.

Meters.

Elements Affecting the Accuracy of Induction Type Watt-Hour Meters. H. W. Young. Illustrates and describes an improved bearing of the "rolling" type, explaining its advantages, and an improved method of light load adjustment. 3500 w. Elec Wld—June 29, 1907. No. 85351.

Photometry.

The Value of Photometry in Central-Station Practice. Robert McCourt. Shows what can be done with a few simple instruments with a fair degree of accuracy. 3500 w. Elec Engr, Lond—July 12, 1907. No. 85862 A.

Power Factor.

Graphical Method of Determining Power Factor from Wattmeter Readings. A. A. Radtke. Brief explanation of method. 400 w. Elec Wld—July 20, 1907. No. 85848.

Switchboards.

Switchboards for Testing Work. Leonard Solomon. Considers the design of switchboards used for testing purposes, and describes the switchboard at present in use at the Central Technical College. Ills. 2800 w. Elect'n, Lond—July 12, 1907. No. 85864 A.

Testing Plant.

A Brief Description of the Testing Department of the General Electric Company; (Schenectady Works). E. L. Simpson. Descriptive of the training given students in this department. Ills. 6000 w. Purdue Engng Rev—1907. No. 85939 N.

Transformer Testing.

A New Method of Artificially Loading Transformers (Eine Neue Methode zur Künstlichen Belastung von Transformatoren). Axel F. Gustrin. Gives diagrams illustrating the wiring arrangements for this method of testing transformers, in which the transformer under test is self-loading. 1600 w. Elektrotech Zeitschr—June 6, 1907. No. 85684 D.

Notes on Transformer Testing. H. W. Tobey. Describes methods adopted in commercial transformer testing which have proved satisfactory, explaining their advantages and shortcomings. 3500 w. Pro Am Inst of Elec Engrs—June, 1907. No. 85758 D.

TRANSMISSION.

Cables.

An Investigation of the Loss of Voltage in Cables (Untersuchung über den Spannungsverlust in Kabeln). E. Stirnimann. A theoretical discussion of the losses of voltage in cables of large section, illustrated by curves, tables and diagrams. 7000 w. Serial, 2 parts. Elektrotech Zeitschr—June 6 and 13, 1907. No. 85685 each D.

Direct Current.

Critical Remarks on Electric Power Transmission by High-Pressure Direct Current (Kritische Betrachtungen über das System der Elektrischen Kraftübertragung mit Hochgespanntem Gleichstrom). A criticism of the paper on the series system of high-tension, direct-current transmission read by J. S. Highfield before the Institution of Electrical Engineers, March 7, 1907. Ills. 3000 w. Elektrotech u Maschinenbau—June 23, 1907. No. 85662 D.

High Tension.

Some New Methods in High-Tension Line Construction. H. W. Buck. Describes a method of line construction believed to offer a means of operating a line safely at higher potentials than is practicable with insulators of the pin and petticoat type. 1000 w. Pro Am Inst of Elec Engrs—June, 1907. No. 85760 D.

Insulators.

A New Type of Insulator for High-Tension Transmission Lines. E. M. Hewlett. Illustrated description of "link insulators" of the suspension and strain type. 500 w. Pro Am Inst of Elec Engrs—June, 1907. No. 85759 D.

Large Systems.

The Development and Operation of a Large Electric Transmission and Conversion System. Ernest F. Smith. Refers particularly to the systems of the Chicago Edison and Commonwealth Electric companies as representing the best American practice. Discussion. Ills. 12900 w. Jour W Soc of Engrs—June, 1907. No. 85726 D.

Lightning Arresters.

A Proposed Lightning-Arrester Test. N. J. Neall. Describes the proposed test, illustrating it by wiring diagrams, and explaining its advantages. 800 w. Pro Am Inst of Elec Engrs—June, 1907. No. 85757 D.

Practical Testing of Commercial Lightning-Arresters. Percy H. Thomas. Discusses what tests should be incorporated in the standardization rules of the Am. Inst. of Elec. Engrs. 13000 w. Pro Am Inst of Elec Engrs—June, 1907. No. 85756 D.

Lightning Protection.

Ground Wires and Choke-Coils for Lightning Protection. D. S. Carpenter. Considers that the overhead ground wire with lightning arresters at intervals along the line affords the best possible protection. 1200 w. Elec Wld—July 20, 1907. No. 85849.

Protective Apparatus Engineering. E. E. F. Creighton. Describes methods which have been in use in the development of lightning apparatus. 15600 w. Pro Am Inst of Elec Engrs—June, 1907. No. 85755 D.

Line Extensions.

Extension of Electricity Supply to Outlying Districts. R. L. Acland. Abstract of a paper read before the Incorporated Municipal Electric Association. Describes the scheme adopted for supplying a district, 2½ miles from the power house, with power for electric lighting. 1500 w. Mech Engr—July 13, 1907. No. 85858 A.

Niagara.

Canadian Niagara Power Company's Transmission to Buffalo. Illustrated description of novel features in the long crossing of the transmission lines, and of terminal station "B" of the Cataract Power & Conduit Co. 2500 w. Elec Wld—June 20, 1907. No. 85340.

Poles.

See Electrical Engineering, Communication.

Three-Phase.

Neutral Currents of a Three-Phase Grounded System. George I. Rhodes. Considers causes producing phase displacement and variation in magnitude of the generated e. m. f. waves. 1200 w. Elec Jour—July, 1907. No. 85707.

MISCELLANY.

Lightning Protection.

Standard Lightning Protection for the Consolidated Power Plant Chimneys at United States Navy Yards. N. Monroe Hopkins. Describes the design of lightning protection for chimneys, giving illustrations of experiments which show reasons for the general features, and the approved specifications. 3500 w. Jour Am Soc of Nav Engrs—May, 1907. No. 85764 H.

Waves.

Applications of Hertzian Waves (Aplicaciones de las Ondas Hertzianas). G. J. de G. Garcia. The first instalment deals principally with the methods of producing electric waves and their naval applications. Ills. 8000 w. Revista Tech Ind—June, 1907. No. 85695 D.

INDUSTRIAL ECONOMY

America.

Industrial America. J. E. Livermore. Comments by a British workman on American machine-shop conditions. Ills. 2500 w. Cassier's Mag—July, 1907. Serial. 1st part. No. 85713 B.

American Railways.

The Crisis in the Railway Affairs of the United States (La Crise des Chemins de Fer aux Etats-Unis). G. M. Boissevain. A discussion of the financial condition of the railways of the United States, outlining the causes of the recent drop in the value of securities and the prospects of the future. Tables. 6000 w. Rev Inter Econ—June, 1907. No. 85606 H.

Apprenticeship.

A Rational Apprentice System. Gives extract from Mr. Deems' address before the Master Mechanics' Assn., and the paper of C. W. Cross and W. B. Russell. Also discussion. 12500 w. Am Engr & R R Jour—July, 1907. No. 85408 C.

The Improvement of Opportunity for the Young Workman. George Frederick Stratton. Outlines the apprenticeship system devised by the General Electric Company, and shows the advantages of study with correspondence schools. 2000 w. Engineering Magazine—Aug., 1907. No. 85920 B.

Argentine Republic.

The Argentine Republic and Its Economic Development (La République Argentine et son Développement Economique). Maurice Lewandowski. Describes the great commercial importance of Argentina, its resources, railways, rivers, etc., outlining the enormous progress made in recent years. 16000 w. Rev Inter Econ—June, 1907. No. 85607 H.

Bills of Lading.

The Uniform Bill of Lading. Discusses the bill proposed by the Interstate Commerce Commission. 2000 w. Ir Age—July 18, 1907. No. 85730.

Brazil.

The Brazil of the Present (Le Brésil Contemporain). E. Levasseur. A review of the economical progress of Brazil during the last fifteen years, describing its resources, mineral wealth, commerce, railways, etc. Tables. 10500 w. Rev Inter Econ—June, 1907. No. 85605 H.

British Industry.

The Trust Movement in British Industry. Reviews a recent book on this subject by Henry W. Macrosty, discussing the reasons why trusts are formed and related matters. 4000 w. Ir Age—July 4, 1907. No. 85442.

Cost Keeping.

Cost Keeping as an Aid in Managing Men. Halbert P. Gillette. Outlines the old method of management, and discusses cost keeping as a means of determining the efficiency of labor. 4000 w. Engng-Con—July 17, 1907. No. 85771.

Cost Keeping in Large Plants (Aus der Praxis des Rechnungswesens in Grossbetrieben). C. Redtmann. Discusses the theory of cost keeping in machine shops. Ills. 1800 w. Serial. 1st part. Zeitschr f Werkzeugmaschinen u Werkzeuge—June 25, 1907. No. 85655 D.

Depreciation.

Depreciation and Reserves for Antiquation and Obsolescence from an Engineering Standpoint. C. H. Yeaman. Abstract of a paper before the Incor. Munic. Elec. Assn. Also discussion. 4500 w. Elect'n, Lond—July 5, 1907. No. 85584 A.

Adequate Depreciation of Capital Expenditure by Municipal Electricity Undertakings. J. Horace Bowden and Fred Tait. A discussion of this subject, with suggestions. 3000 w. Elec Rev, Lond—June 21, 1907. Serial. 1st part. No. 85387 A.

Education.

The Relation of Engineering Schools to Polytechnic Education. Dugald C. Jackson. Presidential address delivered at the Cleveland meeting of the Society for the Promotion of Engineering Education. 4000 w. Ir Trds Rev—July 11, 1907. No. 85529.

The Engineering Side at Bedford Grammar School. Editorial on the work being done at this school, which aims to give instruction that will really assist in the boy's progress. Ills. 2000 w. Engng—July 12, 1907. No. 85872 A.

Employers' Liability.

Workmen's Compensation and Insurance. Jos. J. H. Stansfield. Deals with the effect of the new Employers' Liability Act upon the position of the manufacturer, and shows that, in some ways, the act is obscure. 2800 w. Elect'n, Lond—June 28, 1907. No. 85498 A.

Government Control.

The Canadian Railway Commission. J. G. G. Kerry. An account of the work intrusted to this commission in the regulation of railways. 5000 w. Engineering Magazine—Aug., 1907. No. 85912 B.

Indexing.

An Inexpensive Indexing System. William E. Reed. Describes a system used by the writer. 1500 w. Am Mach—Vol. 30, No. 29. No. 85774.

Industrial Betterment.

How One Corporation Helped Its Employees. Lawrence Lewis. An illustrated account of social betterment work of the Colorado Fuel and Iron Company. 4000 w. Eng & Min Jour—June 29, 1907. No. 85332.

Industrial Legislation.

Industrial Legislation and Its Cost. T. Good. Discusses the effect in Great Britain of the application of legislation to industrial ills. Argues that the benefits cost far more than they would if other means were taken. 3500 w. Cassier's Mag—July, 1907. No. 85710 B.

Industrial Museums.

A Visit to the German Museum at Munich (Ein Besuch im Deutschen Museum in München). Conrad Matschosz. A description of the exhibits at this large and important technical museum. Ills. 3000 w. Zeitschr d Ver Deutscher Ing—June 22, 1907. No. 85679 D.

A Museum of Traffic and Engineering. Dr. Alfred Gradenwitz. An illustrated description of an industrial museum in Germany, the exhibits principally devoted to railroad engineering. 2000 w. Engineering Magazine—Aug., 1907. No. 85913 B.

Iron Industry.

First Quinquennial Census of the Iron and Steel Industry. Reviews the report compiled by Story B. Ladd. 6500 w. Ir Age—July 4, 1907. No. 85441.

Management.

Profit Making in Shop and Factory Management. C. U. Carpenter. This seventh of a series of articles gives a study of the proper time of assembling work. 2200 w. Engineering Magazine—Aug., 1907. No. 85916 B.

Notes on Works Management. R. A. Smart. Outlines the requisites of an industrial organization, discussing some of the more important functions and the methods in common use for controlling them. 3500 w. Purdue Engng Rev—1907. No. 85932 N.

The Proper Management of Labor, a Weighty Factor in Commercial Success (Richtige Arbeitsdisposition, ein wichtiger Faktor des Finanziellen Erfolges). Max Arbeiter. Discusses cost keeping, works organization, etc., with examples of methods from actual plants. Ills. 2500 w. Elektrotech u Maschinenbau—June 9, 1907. No. 85660 D.

Municipal Ownership.

Expert Investigations in Municipal Ownership. Information from a general review of the examinations made in the United States of municipal and private plants by the Municipal Ownership Committee of the National Civic Federation. 2500 w. Elec Wld—July 20, 1907. Serial. 1st part. No. 85845.

Railway Construction.

The Engineering Organization of the Western Pacific Railway Company. George P. Low. Describes the engineering organization for one of the heaviest pieces of railway building ever undertaken, covering 76 miles between Oroville and Spanish Creek Crossing, Cal. 5000 w. Eng Rec—Aug. 3, 1907. No. 86086.

Shop Routine.

The Passage of an Order Through Office and Shop. W. R. Koller. Follows the more important steps of the order and that part of the routine in office and shop which bears directly on its passage. Explains the card-filing system. Ills. Discussion. 10700 w. No. 67. Pro Brooklyn Engrs' Club—1906. No. 85973 N.

Tariff.

French Tariff Negotiations. A statement of the attitude of the French Government toward the reciprocity treaty, calling attention to a forgotten law, and outlining the satisfactory negotiations now being conducted. 1100 w. Ir Age—July 18, 1907. No. 85729.

Tin Plate.

Quinquennial Census of the Tin and Terne Plate Industry. A review of the report for the quinquennial census of 1905, prepared by Story B. Ladd. 2000 w. Ir Age—July 11, 1907. No. 85480.

MARINE AND NAVAL ENGINEERING

Auxiliary Machinery.

Auxiliary Machinery on Merchant Steamers. An illustrated description of auxiliary machinery for engine and boiler-room, for draught and ventilation, refrigeration, deck machinery, steering gears, etc. Supplement also. 22500 w. Engr, Lond—June 21, 1907. No. 85403 A.

Barges.

Barges for Shipment of Coal and Ore. Illustrations and description of a "bunkering barge" intended for discharging coal directly into the bunkers of a steamer. 800 w. Engng—June 28, 1907. No. 85503 A.

Battleships.

French Battleships Republique and Patrie. J. Peltier. Illustrations, description of vessels and equipment, report of trials, and comparison with the American battleship Virginia. 1600 w. Int Marine Engng —Aug., 1907. No. 85905 C.

U. S. S. Kansas. William Ashley Leavitt, Jr. Illustrated description of the vessel and its equipment, with report of official trials. 12500 w. Jour Am Soc of Nav Engrs—May, 1907. No. 85767 H.

Boilers.

A New Cylindrical Marine Fire Tube Boiler. Benjamin Taylor. Illustrates and describes the invention of Mr. Inglis, which is designed to increase the efficiency of the "Scotch" boiler, particularly when working under forced draught in a closed stokehold. 800 w. Boiler Maker—July, 1907. No. 85356.

Cable Steamer.

The Cable Steamer Ogasawara Maru. S. Oi. Illustrated description of this new Japanese steamer and its equipment. 2500 w. Int Marine Engng—Aug., 1907. No. 85908 C.

Compasses.

Compasses on Lake Steamers. Clarence E. Long. Discusses the deviation and changes that make the use of the compass difficult, and methods of verifying or checking the course, giving problems to illustrate Especially explaining the use of Baxter's compass diagram. 3800 w. Marine Rev—July 25, 1907. No. 85965.

Corrosion.

Corrosion of Propeller Shaft, U. S. S. Rhode Island. Henry E. Rhoades. Drawing and descriptive account of the condition discovered, with the writer's explanation of the possible cause. 1200 w. Jour Am Soc of Nav Engrs—May, 1907. No. 85763 H.

Electric Pumping.

The Application of Electricity to the Driving of Pumping Machinery for Pontoon and Graving Docks. W. C. Mountain. Gives examples of docks driven both by steam and electricity, giving the principal data as regards dimensions, pumping machinery, and the cost of pumping per ton docked. Discussion. Ills. 5500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—June, 1907. No. 85823 N.

Engines.

High-Speed Two-Stroke Engines, with Remarks on Internal Water Cooling. T. D. Kelly. Gives descriptions and diagrams showing the evolution of the Duplex two-stroke engine, describing also some improvements which will probably be adopted for large powered marine work. 2800 w. Prac Engr—July 19, 1907. Serial. 1st part. No. 85983 A.

Ferryboats.

New Ferryboats for City of New York. Illustrated detailed description of the new screw ferryboat "Bay Ridge," the latest addition to the municipal ferryboats. 1500 w. Naut Gaz—July 25, 1907. No. 85900.

The Long Island Ferryboat Hempstead. Illustrated description of one of two new ferryboats recently placed in service between 34th St., New York, and Long Island City. 1000 w. Int Marine Engng—Aug., 1907. No. 85907 C.

Fishing Vessel.

The Oil-Motor Herring-Drifter "Thankful." Illustrated description of a fishing-vessel, fitted with an oil-engine rated at 82 indicated horse-power. 1500 w. Engng—July 5, 1907. No. 85593 A.

Lighthouses.

Some New German Lighthouses. Illustrated descriptions of recent types showing the great improvements. 700 w. Engr, Lond—June 8, 1907. No. 85504 A.

Motor Boats.

The Development of Motor-Boat Construction with some Examples of the Applications of the Motor Boat in Naval Service (Die Entwicklung des Motorbootbaues mit besonderer Berücksichtigung der Verwendung von Motorbooten in der Kriegsmarine). W. Kaemmerer. Ills. 3000 w. Zeitschr d Ver Deutscher Ing—June 22, 1907. No. 85680 D.

A New Automobile Boat. Jauques Boyer. Brief illustrated description of a self-propelled vehicle, devised by J. Ravaillier, which can navigate in water or travel overland. 500 w. Sci Am—July 20, 1907. No. 85741.

Naval Science.

Notes on Naval Science Topics. Arthur R. Liddell. Comments of some of the problems in the designing and working of ships, such as proportions, freeboard, etc. 3000 w. Int Marine Engng—Aug., 1907. No. 85911 C.

Navy Yards.

The Position and Equipment of the Puget Sound Navy Yard. H. Cole Estep. A study of American naval interests on the Pacific, especially the location and equipment of dry-docks. Ills. 1500 w. Engineering Magazine—Aug., 1907. No. 85918 B.

Paddle-Steamer.

Paddle-Steamer "Bassein" for the Burma Railway Company. Illustrates and describes a large side-wheel paddle steamer recently built for steam ferry service on the Irrawaddy. 1000 w. Engng—June 21, 1907. No. 85401 A.

Repairs.

Temporary Repairs to Steamer Damaged Abroad. Illustrates and describes temporary repairs made to a ship while off the coast of South America, and nearly 800 miles from the nearest dry-dock. 1000 w. Prac Engr—July 19, 1907. No. 85982 A.

Safeguards.

Electric Safeguards at Sea. A. S. Atkinson. On the electric appliances introduced on modern ships, especially their bearing on fire risks. 2500 w. Int Marine Engng—Aug., 1907. No. 85906 C.

Salving.

Notes on Raising the Gunboat Machias. Illustrates and describes methods of raising this steel gunboat which was sunk during a hurricane. 700 w. Int Marine Engng—July, 1907. No. 85352 C.

The Salving of the "Suevic." A. G. Hood. Illustrated description of a difficult engineering feat. 1300 w. R R Gaz—June 28, 1907. No. 85336.

Shipyards.

Glimpses into Some German Shipyards. Harold A. Everett. Brief illustrated descriptions of the Vulcan yard, and the Howaldtzwerke, are given in the present number. 2000 w. Int Marine Engng—July, 1907. Serial. 1st part. No. 85353 C.

The Société des Chantiers et Ateliers de la Gironde. Plans and description of this shipbuilding yard almost opposite the Bordeaux commercial docks. 1500 w. Engng—June 21, 1907. No. 85398 A.

Slips.

A Simplified Method of Calculating Curved Launching Slips (Vereinfachte Berechnung von Kreisbogenformigen Ablaufsbahnen). Alfred Schwarzenberg. A mathematical paper deducing formulæ for the calculation of launching slips in the form of arcs. Ills. Tables. 2000 w. Schiffbau—June 12, 1907. No. 85644 D.

Sound Signals.

Sound Signals for Mariners: An Inventive Field Which Is Not Overworked. C. H. Claudy. Gives an illustrated outline sketch of the field of sound signals for marine use. 1400 w. Sci Am—June 29, 1907. No. 85313.

Steamships.

The New Turbine Steamship Creole. Illustrated description of a steamship equipped with Curtis turbines. It is for service between New York and New Orleans. 2900 w. Naut Gaz—July 4, 1907. No. 85431.

The Royal Mail Steam Packet Company's T.-S. S. "Avon." Illustrates and describes this vessel which is intended for the South American mail service. Plates. 700 w. Engng—July 5, 1907. No. 85591 A.

The New Hamburg-American Liner President Lincoln. Illustrated description of this new vessel and the equipment. 1200 w. Int Marine Engng—Aug., 1907. No. 85910 C.

Torque.

Torque of Propeller Shafting. J. Hamilton Gibson. Investigations and results. Diagrams. 2800 w. Jour Am Soc of Nav Engrs—May, 1907. No. 85766 H.

Towing.

The Automatic Steam Towing Machine. Thomas S. Kemble. Briefly reviews the history of towing machines, discussing their theory and practical operation, and describes the latest type of Chase towing machine. 2500 w. Int Marine Engng—Aug., 1907. No. 85909 C.

Turbines.

Marine Steam Turbine Development. Hon. C. A. Parsons and R. J. Walker. Deals with the development, giving particulars and results comparing turbine vessels with other vessels fitted with reciprocating engines. Plates. 6000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—June, 1907. No. 85824 N.

The Marine Steam-Turbine. Hon. C. A. Parsons, and H. Wheatley Ridsdale. Read at meeting of the Inst. of Naval Archts. Discusses practical points in the application of the marine steam turbine; the design, construction, and running. Ills. 4000 w. Engng—July 12, 1907. No. 85874 A.

U. S. Navy.

The Vessels and Guns of the Old Navy, 1775-1850. Dr. Charles Oscar Paullin. An illustrated description of the naval vessels of the revolutionary war, and of the war of 1812 and the first half of the 19th century. 2700 w. Sci Am—June 29, 1907. No. 85315.

Warships.

Progress of Warships and Machinery Under Construction in England. Reviews the progress of the past six months. 2000 w. Engr, Lond—July 5, 1907. No. 85594 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

The Present Status of American Air-Cooled Motors (Der Gegenwärtige Stand der Amerikanischen Luftgekühlten Motoren). Alois Riehl. Illustrated description of various types showing present practice in America. 3800 w. Serial. 2 parts. Zeltschl d Mitt Motorwagen-Ver—May 31 and June 15, 1907. No. 85669 each D.

Benz.

The 50-H.P. Four-Cylinder Benz Car. The chief features of this powerful machine are illustrated and described. 2000 w. Autocar—June 22, 1907. No. 85375 A.

Britannia.

The Britannia Petrol Car. Illustrated description of a new car. 900 w. Auto Jour—July 20, 1907. Serial. 1st part. No. 85979 A.

Car Testing.

Wellington's Car Testing Machine. Illustrated description of this machine for testing motor cars, and method of testing. 1200 w. Autocar—July 20, 1907. No. 85981 A.

Cleaning Plant.

An Automobile Vacuum Cleaning Plant. An illustrated description of a combined gasoline motor-propelled vacuum cleaner, in which the engine of the vehicle also drives the vacuum apparatus. 1000 w. Sci Am Sup—July 6, 1907. No. 85413.

Commercial Vehicles.

Motor Truck of the Roth-Gesellschaft in Schöningen (Motorlastwagen der Roth-Gesellschaft in Schöningen). Herr Pflug. Illustrated detailed description of this car for heavy trucking service. 2200 w. Zeitschr d Mitt Motorwagen Ver—May 31, 1907. No. 85670 D.

Design.

The Present Status of the Auotmobile (Ueber den Heutigen Stand unserer Automobile). Hugo Lentz. Considers various points of design and suggests where need for improvement lies. Ills. 4000 w. Zeitschr d Mitt Motorwagen Ver—June 15, 1907. No. 85671 D.

Engine.

A Paraffin Motor Car Engine. Illustrated description of a two-cylinder Allsop engine working on the Otto cycle. 700 w. Engr, Lond—June 21, 1907. No. 85404 A.

Float Chamber.

The Design of a Float Feed Chamber. Leon Carayol. Describes how the level of the petrol is maintained to avoid overflowing, explaining the theory of the design. Ills. 900 w. Autocar—July 20, 1907. No. 85980 A.

Gears.

Electrical Transmission Gears on Motor Vehicles. Alan Archibald Campbell Swinton. Read at Engng. Con. of the Inst. of Civ. Engrs. Briefly describes arrangements adopted. Short discussion. 2000 w. Elec Engr, Lond—June 21, 1907. No. 85383 A.

Horch.

The Horch Petrol Cars. Illustrated description of the chief features of these vehicles, built in Saxony. 1200 w. Auto Jour—June 22, 1907. Serial. 1st part. No. 85376 A.

Junior.

The Junior 18-24 H.P. and 28-40 H.P. Chassis. Illustrates and describes features of these Italian cars. 1200 w. Autocar—June 29, 1907. No. 85492 A.

Locomobile.

The Locomobile Presents Its 1908 Models. Illustrated description of two types, calling attention to new features. 1500 w. Automobile—July 25, 1907. No. 85901.

Materials.

Materials for Automobile Construction. Thomas J. Fay. Extract from Chapter I. of a work on this subject. 3300 w. Automobile—July 11, 1907. No. 85509.

Mercedes.

The 75 H.P. Mercedes. An illustrated description of the new six-cylinder car. 1000 w. Autocar—July 13, 1907. No. 85854 A.

Omnibuses.

Technical Notes on the Motor Omnibuses of London (Technische Betrachtungen über die Londoner Motoromnibusse). Herbert Bauer. Illustrated detailed description of the various types of motor omnibus operating in London. 4000 w. Serial. 1st part. Zeitschr d Mitt Motorwagen Ver—June 15, 1907. No. 85672 D.

The Kriéger Petrol-Electric Motor Omnibus (La Voiture Pétrolés-Electrique, Système Kriéger). F. Drouin. An illustrated description of this motor omnibus in service at Berlin. 2000 w. Génie Civil —June 1, 1907.. No. 85613 D.

Regulations.

How France Controls Her Automobilists. W. F. Bradley. Information in regard to regulations for owners and operators, system of identification, etc. 1500 w. Automobile—July 4, 1907. No. 85436.

Steering.

Types of Automobile Steering Mechanisms. E. J. Bartlett. Discusses their comparative merits for various kinds of service, and the principles controlling their design and laying out. Diagrams. 4000 w. Am Mach—Vol. 30, No. 30. No. 85882.

COMBUSTION MOTORS.

Furnace Gases.

The Economical Production of Power from Furnace Gases (Production Economique de la Force Motrice au Moyen des Gaz Métallurgiques). Ch. Dantin. Illustrated description of the power plant of the Cockerill Company at Seraing, Belgium, which utilizes coke-oven and blast-furnace gases. 5000 w. Génie Civil—June 29, 1907. No. 85618 D.

The Use of Excess Gas from By-Product Coke Ovens for Light and Power Purposes. C. E. Rhodes. Gives particulars taken from the actual working results of two batteries of ovens, one with horizontal and the other with vertical flues. 1200 w. Ir & Coal Trds Rev—June 28, 1907. No. 85507 A.

Gas Engines.

Some Notes on Gas Engines. Prof H. Diederichs, in *Sibley Jour. of Engng.* Discusses some of the interesting tests and treatises that have appeared in German literature, with data observed by the writer. 19800 w. Jour Am Soc of Nav Engrs—May, 1907. No. 85762 H.

A New Line of Horizontal Engines. Illustrates and describes single cylinders, twin cylinders and cylinders arranged in tandem. 1200 w. Engr, U S A—July 1, 1907. No. 85374 C.

Roots Two-Stroke Cycle. Internal-Combustion Engine. Sectional elevations and description of a new engine patented by J. D. Roots, London. 1500 w. Mech Engr—July 13, 1907. No. 85859 A.

A Notable Tod Gas Engine. Brief illustrated description of an engine installed at the Youngstown, O., works of the Carnegie Steel Company. 800 w. Ir Age—July 18, 1907. No. 85728.

Power from Producer Gas. G. W. Munro. Describes a producer gas engine plant, and gives a report of its efficiency and performance. 3000 w. Purdue Engng Rev—1907. No. 85937 N.

The Gas Power Plant of the Norton Company. An illustrated general outline of the plant, with report of its performance under every-day conditions. 1500 w. Power—July, 1907. No. 85343 C.

A Mammoth Alternating-Current Gas Engine Railway Plant. Describes a San Francisco plant where twin tandem, double-acting engines operating on crude oil water gas are installed. Ills. 1500 w. Engr, U S A—July 15, 1907. No. 85557 C.

Gas Holders.

See Civil Engineering, Construction.

Gas Producers.

Gas Producers (Ueber Gasgeneratoren). Discussion of Johannes Körting's paper before the Verein Deutscher Eisenhüttenleute and reprinted in *Stahl und Eisen* for May 15, 1907. Ills. 4500 w. Stahl u Eisen—June 5, 1907. No. 85625 D.

Discussion of the Theoretical Performance of Coke Gas Producers (Représentation du Fonctionnement Théorique des Gazogènes au Coke). Rodolphe Soreau. A mathematical explanation of simple means for making calculations in gas producer practice, including composition of gas, calorific power of gas, thermal efficiency of the producer, etc. 3000 w. Mem Soc Ing Civ d France—May, 1907. No. 85602 G.

Ideal Engine.

The Ideal Internal-Combustion Engine. E. N. Percy. Outlines an engine embodying the best points of long-tried engines. 1400 w. Power—July, 1907. No. 85342 C.

Ignition.

Some Facts Pertaining to Electrical Ignition. Henry G. Chatain. Extract from a paper read before the Soc. of Auto. Engrs., N. Y. Describes tests made to determine the most favorable operating conditions of a Simms-Bosch low-tension magneto. Also gives tests of some high-tension coils. Diagrams. 1200 w. Automobile—July 18, 1907. No. 85768.

Lubrication.

The Lubrication of Petrol Engines. J. Veitch Wilson. Deals with the various methods adopted for the application of lubricants and adaptability of the lubricants to these different methods. 1300 w. Autocar—July 6, 1907. Serial. 1st part. No. 85578 A.

Natural Gas.

Natural Gas Plant of Art Metal Construction Co. Illustrated description of a power plant at Jamestown, N. Y., having two twin and one large tandem unit, the latter controlled by a flywheel governor, all running on natural gas. 3000 w. Engr, U S A—July 15, 1907. No. 85558 C.

Oil Engines.

A Large Oil Engine Plant. Oil engines run in parallel on a power and lighting load at the works of the Ball Bro.'s Glass Mfg. Co., Muncie, Ind. Ills. 2500 w. Engr, U S A—July 15, 1907. No. 85561 C.

Peat-Alcohol.

Alcohol from Peat. Briefly describes the nature of certain processes for the extraction, on a large scale and at a low cost, of alcohol from peat. Also considers the possibility of utilizing this fuel. 3000 w. Auto Jour—July 20, 1907. No. 85978 A.

Producer Plants.

An Interesting Suction Gas Producer Plant. Illustrated description of anthracite producers installed in a factory in

Cleveland, O., for which the exhaust of the engine is utilized in making steam. 2200 w. Engr, U S A—July 15, 1907. No. 85560 C.

Producer Plant of the John Thompson Press Co. Godfrey M. S. Tait. This plant in Long Island City, N. Y., is illustrated and described in detail. 2000 w. Engr, U S A—July 15, 1907. No. 85559 C.

Water Gas.

The Value of Water Gas (Zur Bewertung des Wassergases). Franz Schäfer. A criticism of Herr Kayser's article in *Gesundheits-Ingenieur* for April 6, 1907, taking exception to many of the latter's statements as to the value of water gas for heating, lighting and power purposes. 2500 w. Gesundheits-Ing—June 22, 1907. No. 85654 D.

HEATING AND COOLING.

Car Heating.

A Method of Ventilating and Heating Railroad Cars. Drawings and description of E. R. Swan's idea of a proper method of warming and ventilating railroad cars. 1400 w. Met Work—July 6, 1907. No. 85406.

Central Plants.

Heating and Ventilating a Group of Public Schools. Samuel R. Lewis. Read before the Am. Soc. of Heat. & Vent. Engrs. Plans and description of a plant in Galesburg, Ill., which furnishes steam heat, electric current for lighting and power, and compressed air for various purposes, to three school buildings located on the same block. 1800 w. Heat & Vent Mag—July, 1907. No. 85828.

Results of Operation of the Municipal Central Heating and Electric Plant at Dresden (Ueber die Betriebsergebnisse des Kgl. Fernheiz- und Elektrizitätswerkes zu Dresden). R. Trautmann. Paper read before the Convention of Heating and Ventilating Engineers at Vienna, 1907. Gives costs and details of operating a central plant for heating and lighting a group of municipal buildings. Ills. 4000 w. Gesundheits-Ing—June 2, 1907. No. 85652 D.

Dwellings.

The Heat Absorption and Transmission of the Outer Walls of Buildings (Wärmeaufnahme und -abgabe der Umfassungswände von Gebäuden). G. de Grahl. Paper read at the Convention of Heating and Ventilating Engineers at Vienna, 1907. Refers principally to dwelling houses and gives numerous diagrams, curves, and tables. 7500 w. Gesundheits-Ing—June 2, 1907. No. 85651 D.

Electric.

Electric Cooking and Heating in Hotels. An illustrated account of two heating and cooking installations of considerable size in Switzerland, giving details of apparatus used. 2000 w. Elect'n, Lond—July 19, 1907. No. 85986 A.

Gas.

The Testing and Hygienic Efficiency of Gas Fires. Jno. H. Brearley. Read before the Inst. of Gas Engrs. An account of the tests made by the writer for radiation, for heat convection, and for carbon monoxide. 4500 w. Engr, Lond—July 12, 1907. No. 85876 A.

History.

The History of Heating Engineering up to the Year 1870 (Aus der Geschichte der Zentralheizungs-technik bis zum Jahre 1870). Hermann Vetter. Paper read at the Convention of Heating and Ventilating Engineers at Vienna, 1907. An exhaustive historical review of heating methods prior to 1870. Ills. 15000 w. Gesundheits-Ing—June 2, 1907. No. 85650 D.

Hospitals.

The Heating and Ventilating of Hospitals (Heizung und Lüftung in Krankenhäusern). H. Rietschel. Paper read before the Convention of Heating and Ventilating Engineers at Vienna, 1907. Discusses the peculiar problems in hospital heating and ventilating. 5000 w. Gesundheits-Ing—June 8, 1907. No. 85653 D.

Heating and Ventilating a Hospital in New York. A notable example, in which air is distributed from a large plenum chamber and heated in a solarium by hot water from steam, is illustrated and described. The Willard Parker hospital. 3500 w. Met Work—July 6, 1907. No. 85405.

Hotel.

Heating and Ventilating the Hotel Knickerbocker, New York City. Illustrates and describes the mechanical equipment for this fine hotel, at Broadway and 42d St. 3800 w. Eng Rec—July 13, 1907. No. 85541.

Refrigeration.

The Present Condition of the Refrigeration Industry (Etat Actuel de l'Industrie Frigorifique). Ch. Lambert. An exhaustive review of the industrial applications of refrigeration, the methods and machines used, and the theories involved in its development. Ills. Tables. 32000 w. Mem Soc Ing Civ d France—April, 1907. No. 85600 G.

The Value of the Indicator in Refrigeration Work. Dr. Joseph H. Hart. Its usefulness shown by analogy to steam-engine practice. Discusses the standard diagram and its meaning in compression. 3000 w. Engineering Magazine—Aug., 1907. No. 85919 B.

Electric Refrigeration in a Wholesale Produce House. Illustrates and describes an example of the use of automatic electric refrigeration in Lowell, Mass. 800 w. Elec Wld—July 6, 1907. No. 85486.

Steam Heating.

The Combined Pressure and Vacuum System of Steam Heating. George D. Hoffman. Read before the Am. Soc. of Heat. & Vent. Engrs. Presents the advantages claimed for this new system of vacuum steam heating. 2500 w. Heat & Vent Mag—July, 1907. No. 85829.

A New Method in Vacuum Heating. A brief description of an improvement and a statement—the advantages of compounding heating coils to save steam. 1500 w. Engr, U S A—July 1, 1907. No. 85373 C.

Heating and Ventilating the Budapest Stock Exchange. Charles Knuth. From a paper read before the Inst. of Heat. & Vent. Engrs. at Windsor, Eng. Gives a detailed explanation of steam pipe size determinations, and other features of the system installed. 2800 w. Met Work—July 13, 1907. No. 85500.

HYDRAULICS.

Pumping.

Pump Slippage. Alba L. Holmes. Gives results of tests made for slippage, and troubles due to it. Short discussion. 2700 w. Pro Am Water Wks Assn—1906. No. 85810 N.

Turbines.

Recent High-Speed Turbines (Neuere Schnelläufer-Turbinen). V. Graf and D. Thoma. Illustrates and describes improved water turbines in both Europe and America, giving efficiency curves, etc. 4000 w. Zeitschr d Ver Deutscher Ing—June 29, 1907. No. 85681 D.

The Lorenz Turbine Theory (Zur Lorenzschen Theorie der Kreiselräder). W. Bauersfeld. A mathematical paper taking exception to some of the conclusions reached by Dr. Lorenz. 2500 w. Zeitschr f d Gesamte Turbinenwesen—June 20, 1907. No. 85643 D.

Speed Regulation of High Head Water Wheels. H. E. Warren. Considers in detail the special features in the development of water power under high heads and the methods of control. Ills. 6000 w. Tech Qr—June, 1907. No. 85719 E.

Units.

A New Hydraulic Unit. Daniel W. Mead. Brief explanation of the "cylinder inch" and its use. 500 w. Pro Am Water Wks Assn—1906. No. 85812 N.

MACHINE WORKS AND FOUNDRIES.

Arbors.

Making an Accurate Arbor. Harry A. S. Howarth. Describes method. Ills. 1000 w. Mach, N Y—July, 1907. No. 85484 C.

Ball Bearings.

Elimination of Friction in Ball Bearings. J. F. Springer. Analyzes the sources of friction, showing the importance of this question in view of the application of such bearings in heavy work. Ills. 2000 w. Am Mach—Vol. 30, No. 30. No. 85883.

Brass Casting.

Regulations for the Casting of Brass. Gives draft of regulations proposed in substitution for the special rules now in force. 1000 w. Engr, Lond—July 5, 1907. No. 85596 A.

Brass Refuse.

The Treatment of Brass Foundry and Brass-Rolling Mill Refuse. Erwin S. Sperry. An illustrated description of methods in use to prevent abnormal waste in brass mills. Describes the "Hill Barrel" and its use, washing methods, treatment of slags, skimmings, sweeps, etc. 4500 w. Brass Wld—July, 1907. No. 85825.

Case Hardening.

Chemical and Metallographical Researches on Case Hardening (Chemische und Metallographische Untersuchungen des Hartgusses). H. Wedding and Fritz Cremer. A report of an exhaustive investigation of the changes in composition and structure of steel during the case-hardening process. Ills. Serial. 1st part. 3000 w. Stahl u Eisen—June 12, 1907. No. 85627 D.

Castings.

An Interesting Molding-Machine Job. Robert Patten. Showing how nine different castings can be produced from one machine, by making a few alterations in its set-up. Ills. 1800 w. Am Mach—Vol. 30, No. 29. No. 85778.

Cast Thread Fittings. Henry B. Cutler. Read before the Am. Found. Assn. Brief account of the principles and method of making gray iron castings with threads cast in them. 700 w. Foundry—July, 1907. No. 85745.

Chips.

Why Chips Cling to Screw-Machine Tools. C. L. Goodrich. Shows how improper clearance, incorrect rake, excessive speed, etc., cause the chips to heat and weld to the cutting edges of tools. Ills. 1200 w. Am Mach—Vol. 30, No. 30. No. 85881.

Copper.

Copper for the Foundry. F. L. Antisell. Read before the Am. Found. Assn. Discusses points the buyer should consider, such as brand, conductivity, analysis, shape, etc. 1500 w. Foundry—July, 1907. No. 85748.

Cupolas.

Comparative Cupola Practice. W. S. McQuillan. Read before the Am. Found. Assn. Gives tabulated results from a number of foundries, comparing results and giving conclusions. 1700 w. Foundry—July, 1907. No. 85747.

Cutters.

The Fly Cutter in Punch and Die Work. Describes an original method of producing complex shapes by a system of elementary cutters and milling-machine adjustments. Ills. 1600 w. Am Mach—Vol. 30, No. 30. No. 85880.

Dials.

Making a Set of Accurate Index Dials. F. A. Stanley. Explains how a set of seven index dials was originated with the aid of some accurate fixtures. Ills. 4500 w. Am Mach—Vol. 30, No. 28. No. 85565.

Fluxes.

Foundry Fluxes or Deoxidants. Walter J. May. Suggestions for fluxing iron, copper alloys, and other metals. 700 w. Prac Engr—June 28, 1907. No. 85493 A.

Fly-Wheels.

Size, Weight and Capacity of Fly-Wheels for Punches. Frank B. Kleinhaus. Gives a method of determining the size, weight and capacity of a fly-wheel to punch a given size hole through a given thickness of metal. Ills. 2500 w. Mach, N Y—July, 1907. No. 85482 C.

Foundries.

Foundry Design. F. A. Coleman. From a paper read before the Am. Found. Assn. Discusses the requirements and form of construction best adapted to secure desired results. 3500 w. Ir Age—July 11, 1907. No. 85481.

The Foundries of the Atlas Engine Works, Indianapolis. Brief illustrated descriptions of the light and heavy work foundries. 1200 w. Ir Trd Rev—July 11, 1907. No. 85526.

Furnaces.

The Oil Furnace vs. the Sheeler-Hemsher Improved Crucible Furnace. W. H. Kane. Read before the Am. Found. Assn. On the development of the Sheeler-Hemsher forced draft crucible furnace. 1500 w. Found—July, 1907. No. 85749.

Galvanizing.

Galvanizing by the Zinc Bath and Electrolytic Methods (Zingage à Chaud et Galvanisation Electrolytique). A comparison of the two methods as to economy and efficiency, showing the electrolytic method to be greatly superior. 2000 w. Métallurgie—June 19, 1907. No. 85611 D.

Green Gold.

Green Gold Deposits and How They Are Produced. Explains methods of plating, giving solutions for light green, and for dark green deposits. Ills. 1200 w. Brass Wld—July, 1907. No. 85827.

Grinder.

5 x 48-Inch Automatic Sizing Grinder. Illustrated description of a machine having an electrically controlled feed and sizing device for enabling duplicate work to be automatically ground. 2800 w. Am Mach—Vol. 30, No. 27. No. 85463.

Machine Tools.

Machine Tools in a Concrete Machine Shop. L. P. Alford. Deals with the arrangement of departments and methods of setting machine tools in the buildings of the United Shoe Machinery Company. Ills. 3000 w. Am Mach—Vol. 30, No. 27. No. 85461.

Some Recent Developments in Machine Tools. Joseph Horner. Calls attention to some recent improvements in design, and illustrates and describes some of the later machines. 5000 w. Cassier's Mag—July, 1907. Serial. 1st part. No. 85714 B.

Metallography.

The Uses of Microscopic Metallography in Industry (L'Utilisation Industrielle de la Métallographie Microscopique). Léon Guillet. Describes the method of preparing and examining specimens and outlines what may be learned through the microscopic study of steels, brass, bronze, and other alloys. Ills. Serial. 2 parts. 7000 w. Génie Civil—June 15 and 22, 1907. No. 85617 each D.

Molding.

Plate Molding—A Three-Part Piece Made in a Two-Part Flask. G. Buchanan. Illustrated description of method. 500 w. Am Mach—Vol. 30, No. 29. No. 85776.

The Universal System of Machine Molding. E. Ronceray. Read before the Am. Found. Assn. Describes a French method for the manufacture of pattern and stripping plates in the foundry instead of the machine shop. Ills. 3000 w. Foundry—July, 1907. No. 85746.

Molds.

Steel Molds for Casting Small Parts. Charles Petitjean. Illustrates two examples of this work and gives a description of each. 900 w. Am Mach—Vol. 30, No. 28. No. 85569.

Nurls.

Making Nurls. E. A. Dixie. Illustrates and describes methods used. 1000 w. Am Mach—Vol. 30, No. 27. No. 85462.

Riveters.

Improvements on Compressive Riveters. Chester B. Albree. Illustrating and describing the advances that have been made in riveters for concrete mixers and a new type of boiler riveter. 2200 w. Am Mach—Vol. 30, No. 28. No. 85568.

Riveting.

How to Heat and Drive Steel Rivets. T. C. Best. Third prize in the Champion contest. Considers various methods of driving steel rivets, with a view to making them tight. 6500 w. Boiler Maker—July, 1907. No. 85355.

Screws.

Lead and Pitch of a Screw—What They Are. Oscar J. Beale. Explains these terms as used by Brown & Sharpe. 1400 w. Am Mach. Vol. 30, No. 29. No. 85777.

Shears.

Recent Plate Shears (Ueber neuere Blechsheren). Illustrated description of recent shearing machines for heavy service, operated by electricity and water power. 2000 w. Stahl u Eisen—June 19, 1907. No. 85628 D.

Shops.

Planning the Work in a Shop. S. H. Bunnell. Suggestions for foremen showing the value of a system. 1500 w. Am Mach—Vol. 30, No. 28. No. 85567.

Stamp End Works, Lincoln. An illustrated article describing notable improvements recently effected at these English works. Plate. 4000 w. Engng—June 21, 1907. No. 85399 A.

General Concrete Machine Shop Equipment. L. P. Alford. Illustrates and describes the equipment of buildings other than those devoted to manufacturing purposes, in the plant of the United Shoe Machinery Co., Beverly, Mass. 2200 w. Am Mach—Vol. 30, No. 29. No. 85775.

Soldering.

Soldering and Soldering Processes. The form of solders and the process of soldering are discussed. 2200 w. Sci Am Sup—July 6, 1907. No. 85415.

"Verde-Antique."

The Rapid Production of the "Verde-Antique" Finish; and the Method of Obtaining the Various Shades. Information and directions for producing this finish. 3000 w. Brass Wld—July, 1907. No. 85826.

Welding.

Autogenous Welding of Metals. Ernest Schneider. Abstract translation of a paper read in Chemnitz, Germany. Describes applications of the oxy-hydrogen and oxy-acetylene flames. 3000 w. Sci Am Sup—July 20, 1907. No. 85743.

Oxy-Acetylene Blowpipe Welding. W. H. Booth. Explains the use of this method in making reinforced tubes for automobile work, its possibility for boilers and reasons for its intense heat. Ills. 2000 w. Am Mach—Vol. 30, No. 28. No. 85566.

Wire Drawing.

The Heating of Charges for Wire Drawing (Die Erwarmung eines Drahtformigen Schmelzeinsatzes). Fritz Emde. A theoretical and mathematical discussion of the subject. Ills. 6000 w. Serial. 2 parts. June 16 and 23, 1907. No. 85661 each D.

Rubber Covered Wire.—Its Manufacture and Tests in Regard to Its Life and Insulation Properties. Hugh T. Wreaks. Gives an outline of the manufacture of low-voltage rubber covered wire, showing the possibilities of adulteration, and the difficulty of detection. Ills. Discussion. 7500 w. No. 68. Pro Brooklyn Engrs' Club—1906. No. 85974 N.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

Nickel-Chrome Steel. E. F. Lake. Explains the effect of chromium, of silicon, of manganese, of phosphorus and sulphur, the heat treatment, machinery, etc. 2500 w. Mach, N Y—July, 1907. No. 85485 C.

Properties and Uses of Vanadium Steel. Extracts from a lecture by J. Kent Smith before the Assn. of Automobile Mfrs., New York. 3500 w. Ir Trd Rev—July 11, 1907. No. 85527.

Automobiles.

See Mechanical Engineering, Automobiles.

Lubricants.

The Selection of a Proper Lubricant. Roger B. Whitman. Information in regard to lubricants and methods of testing, with suggestions for the selection of an oil. 1600 w. Automobile—July 11, 1907. No. 85510.

Steel.

Steel as an Engineering Material. William Stuart Standiford. Describes steel made by the crucible, open-hearth, and Bessemer processes discussing its quality, uses, etc. 2000 w. Ry & Loc Engng—July, 1907. No. 85427 C.

The Use of High-Tensile Steel. Gives three papers dealing with high-tensile steel in various departments of engineering construction, with discussion. The papers of A. E. Seaton, Edwin William De Russett, and Alfred Fernandez Yarrow, presented at the Engineering Conference. 6000 w. Ir & Coal Trds Rev—June 28, 1907. No. 85508 A.

Wastes.

The Systematic Treatment of Metalliferous Waste. L. Parry. The present article discusses the general economic principles, the valuation of various waste products, and the sources of supply. 3000 w. Min Jour—July 6, 1907. Serial. 1st part. No. 85587 A.

MEASUREMENT.

Color Meter.

A New Color Meter. Frederic E. Ives. Describes a direct vision instrument with all the operating adjustments controlled by screws a few inches from the eye, and its operation. 3500 w. Jour Fr Inst—July, 1907. No. 85703 D.

Dynamometer.

Something New in the Measure of Power. Illustrates and describes a piece of apparatus which, while retaining the conveniences of the electric motor as a source of power in power tests, gives the power measurements directly. 700 w. Am Mach—Vol. 30, No. 27. No. 85460.

Gas-Calorimeter.

Beasley's Recording Gas-Calorimeter. Illustrated detailed description of a new form of calorimeter giving the low-value calorific power. 2000 w. Engng—July 12, 1907. No. 85871 A.

Torsometers.

Torsometers. Archibald Denny. Read before the Inst. of Naval Archts. Deals with torsometers as applied to the measurements of power in turbines and reciprocating engines. Ills. 2200 w. Jour. Am Soc of Nav Engrs—May, 1907. No. 85765 H.

Weighing Machines.

Automatic Coin-Weighing Machines. A. L. Lambert. Illustrated description of one of the new machines made at the machine shops of the Philadelphia mint. 1200 w. Am Mach—Vol. 30, No. 27. No. 85464.

POWER AND TRANSMISSION.

Air Compression.

The Antecooler, the Intercooler, and the Aftercooler. Frank Richards. Information concerning these useful devices in air compression. 1500 w. Compressed Air—July, 1907. No. 85898.

Air Compressors.

The New Franklin Air Compressor. Illustration, with description. 1500 w. Foundry—July, 1907. No. 85751.

The Most Suitable Motive Power for Compressors (Zur Frage des Zweckmässigsten Antriebs für Kompressoren). Fr. Harth. A detailed analysis of the costs of driving an air compressor by steam and by electric power. Ills. 3300 w. Glückauf —June 29, 1907. No. 85634 D.

Belt Tightening.

Power Transmission by Artificially Tightened Belts, Particularly the "Lenix" System (Sur la Transmission par Courroie à Tension Artificielle, en particulier le Système "Lenix"). P. Daubresse. Paper read before the International Congress at Liége, 1905. Describes various systems of belt tighteners with mathematical discussion of their design. Ills. 9500 w. L'All Indus—June, 1907. No. 85612 D.

Chain Driving.

The Morse Chain on Cone Sprockets. Illustrates and describes a mechanical device forming a substitute for cone pulleys and belts and for gear boxes for main drives. 1000 w. Am Mach—Vol. 30, No. 29. No. 85773.

Coal Handling.

Coal and Coke Handling at the Astoria Light, Heat & Power Co.'s Plant, Astoria, L. I. Alfred Kauffmann. Illustrated description of this installation. 1500 w. Eng News—July 11, 1907. No. 85574.

Cranes.

Vertical vs. Horizontal Cranes: A Comparison. An investigation of the special advantages and applications of each. Ills. 1800 w. Prac Engr—July 12, 1907. No. 85855 A.

Machinery of the 150-Ton Hammer-Head Crane at Clydebank. Illustrated detailed description of this electric crane at the shipbuilding yard at Clydebank. 2 plates. 3500 w. Engng—June 21, 1907. No. 85400 A.

Electric Freight-Handling Cranes for the Panama Railway. Illustrated description of cranes for the La Boca pier of the Pacific terminal. Designed to operate in a narrow space and to provide for a tidal variation of 20 ft. 500 w. Eng News—July 25, 1907. No. 85886.

Special Derricks and Buckets for the Construction of a Reinforced-Concrete Warehouse at Chicago. Illustrated description of a steel derrick with 135-ft. mast and 85-ft. boom. Also a dumping bucket of special design. 1600 w. Eng News—July 25, 1907. No. 85884.

Dock Machinery.

Machinery for Mercantile Ports (Attrezzatura dei Porti Mercantili). A. Gullini. Illustrated description of dock machinery, cranes, etc., exhibited at the Milan exposition, 1906. Serial. 1st part. 1600 w. Monit Tech—June 10, 1907. No. 85621 D.

Dock Equipment; Including the Relative Advantages of Electric and Hydraulic Appliances. W. W. Squire. Read at Engng. Con. of the Inst. of Civ. Engrs. Considers appliances for the handling of cargo. Discussion. 2700 w. Elect'n, Lond—June 21, 1907. No. 85391 A.

Electric Transporters at Mersey Dock. Illustrations and brief description of transporters designed for the rapid handling of general cargo, and to run along the shed-roofs. 500 w. Engng—July 5, 1907. No. 85590 A.

Elevators.

The Elevator and Escalator Equipment of the New York Subway. Illustrated description of arrangements for handling large crowds, using the power from the subway. 2500 w. Eng Rec—July 20, 1907. No. 85790.

Electric v. Hydraulic Lifts. Percy Good. A criticism of statements in a recent pamphlet published by the London Hydraulic Power Co., dealing with the comparative safety, convenience, and economy of the two forms of lift-driving. 1500 w. Elec Rev, Lond—July 5, 1907. No. 85582 A.

Power Plant.

Power Plant of the West Street Building, New York City. Illustrated detailed description of the mechanical plant installed in a 23-story, steel-cage office building, on the Hudson River front. 4500 w. Eng Rec—July 27, 1907. No. 85946.

Winches.

The Lidgerwood Electric Friction-Driven Winches for Car Ferries. Illustrated detailed description. 1700 w. Eng News—July 11, 1907. No. 85575.

STEAM ENGINEERING.

Boiler Management.

Boiler, Engine and Generator Testing and Management. Charles L. Hubbard. The present number considers the management of steam boilers. 3000 w. Elec Rev, N Y—July 13, 1907. Serial. 1st part. No. 85532.

Boiler Plant Economy. C. H. Hurd. Discusses the advantage of a system of records, the choice of fuels, boiler room methods, etc. 3000 w. Pro Am Water Wks Assn—1906. No. 85814 N.

Boilers.

Steam Boilers. Traces the evolution of heat and its influence on the heating surfaces. 900 w. Prac Engr—July 12, 1907. Serial. 1st part. No. 85856 A.

Boiler Efficiencies. Editorial on the experiments now being conducted by the boiler division of the United States Geological Survey fuel-testing plant at St. Louis, Mo. 800 w. R R Gaz—July 12, 1907. No. 85513.

Arch Tubes and Brick Arches. G. W. Bennett. Gives results of a recent test made with a wide fire-box type of boiler to ascertain the efficiency of the brick arch and arch tubes, describing the test. 2000 w. Boiler Maker—July, 1907. No. 85358.

Capacities of Cast-Iron Sectional Boilers. Kenneth Gray. Read before the Inst. of Heat. & Vent. Engrs. An examination of things affecting boiler capacity, discussing also its efficiency and working qualities. 3000 w. Archt, Lond—June 28, 1907. No. 85489 A.

Waste Heat Boilers for Copper Smelting Furnaces. Plan and description of an interesting installation at a smelting plant at Butte, Montana, for the utilization of waste heat. 1200 w. Eng Rec—July 6, 1907. No. 85457.

See also Marine and Naval Engineering, and Railway Engineering, Motive Power and Equipment.

Combustion.

Efficiency in the Burning of Fuel Under the Steam Boiler. William D. Ennis. This third article of a series considers the modifications of draft required by commercial fuels. 3000 w. Engineering Magazine—Aug., 1907. No. 85917 B.

Feed Water.

How Should the Feed Water Be Heated? A. J. Albright. A discussion of the best known methods; and formula for calculating the saving by heating with exhaust steam. 2800 w. Power—July, 1907. No. 85348 C.

Fly-Wheels.

Inexpensive Devices for Prevention of Fly-Wheel Wrecks. E. E. Clock. Illustrates three devices which can be installed at small cost. 700 w. Power—July, 1907. No. 85346 C.

Fuels.

Some Comparative Fuel Values. P. N. Evans. Briefly considers solid, liquid, and gaseous fuels. 1500 w. Purdue Engng Rev—1907. No. 85938 N.

Changing from Wood Fuel to Crude Oil. J. E. Anderan. Describes and illustrates the change by which a saving of $12.90 every 24 hours was made possible. 900 w. Power—July, 1907. No. 85347 C.

Heat Production and the Constituents of Coal. S. W. Parr. Considers the varying proportions of combustible elements present and how they affect the heat value of the fuel. 2800 w. Eng & Min Jour—June 29, 1907. No. 85334.

Fuel Tests.

A Review of the United States Geological Survey Fuel Tests Under Steam Boilers. L. P. Breckenridge. Also discussion. 19600 w. Jour W Soc of Engrs—June, 1907. No. 85723 D.

Lubricating Oils.

Lubricating Oils (Les Huiles à Graisser). Ch. Baron. Outlines the characteristics of a good lubricating oil, particularly for use in engine cylinders, with description of methods and apparatus for testing. Curves and tables. 2500 w. Mem Soc Ing Civ d France—May, 1907. No. 85601 G.

Lubrication.

The Lubrication of High-Speed Machinery (Die Schmierung Schnellaufender Maschinen). K. Lenz. Describes methods used for lubricating journals, crossheads, pistons, eccentrics, etc. Ills. 6500 w. Zeitschr d Ver Deutscher Ing—June 1, 1907. No. 85675 D.

Pumping Costs.

Comparative Cost of Pumping by Steam, Internal-Combustion Engines, and Electricity, Based Upon Actual Working. Charles Hawksley and Henry Davey. Read before the Engng. Con. of the Inst. of Civ. Engrs. Short discussion. 1500 w. Elec. Engr, Lond—June 21, 1907. No. 85382 A.

Pumping Engines.

New Pumping Engines of the Hamburg Water Works (Neuere Pumpmaschinen des Hamburger Wasserwerkes). Rud. Schröder. A well-illustrated description of these large pumping engines with details of their operation, coal and steam consumption, efficiency, etc. 4000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—June 15, 1907. No. 85677 D.

Most Efficient Ratio of Steam Cylinders in Direct-Acting Compound Pumps. F. F. Nickel. Mathematical discussion, illustrating by examples. 700 w. Power—July, 1907. No. 85345 C.

Steam Plant.

A One Hundred Horse-Power Steam Plant. Descriptions of such plants by James F. Hobart, M. B. Godfrey, and C. R. McGahey. Ills. 7500 w. Power—July, 1907. No. 85340 C.

Superheating.

Superheated Steam. Thomas Sugden. Read before the South Wales Inst. of Engrs. On the properties of saturated and superheated steam, specific heat, losses, volume, efficiency, economy, etc. 3000 w. Mech Engr—June 29, 1907. Serial. 1st part. No. 85494 A.

Turbines.

The Steam Turbine. Charles Proteus Steinmetz. Explains the principles of the impulse turbine and the reaction turbine, and the problem of developing the steam turbine. Ills. 4000 w. Cassier's Mag—July, 1907. No. 85712 B.

Remarks on Impulse Steam Turbines (Einiges über Aktionsdampfturbinen). Felix Langen. A mathematical discussion of friction in impulse turbines to determine the most efficient design. 3000 w. Zeitschr f d Gesamte Turbinenwesen—June 20, 1907. No. 85642 D.

Steam Turbine Theory (Zur Theorie der Dampfturbine). A. Stodola. A mathematical paper discussing, in the first instalment, the influence of variations in speed on the distribution of pressure and on steam consumption. Ills. Serial. 1st part. 4000 w. Zeitschr f d Gesamte Turbinenwesen—June 10, 1907. No. 85641 D.

Steam Turbines and Central Stations (Las Turbinas de Vapor y las Centrales Eléctricas). Emilio Guarini. A review of the development of the steam turbine and a discussion of its use in generating electric power. 5000 w. La Ingenieria—May 30, 1907. No. 85693 D.

See also Marine and Naval Engineering.

Turbine Testing.

An Oil Fired Boiler for Testing Steam Turbines. F. W. Feiker. Illustrated description of a system well adapted for varying loads. 1000 w. Engr, U S A—July 1, 1907. No. 85372 C.

Valves.

Fitting a Throttle Valve. Suggestions for the careful grinding of the valve and the fitting of the throttle rod and attachments. 800 w. Ry & Loc Engng—July, 1907. No. 85429 C.

Water Hammer.

The Principal Investigations of Water Hammer, with Especial Reference to Those of Prof. N. Joukovsky (Notice sur les Principaux Travaux Concernant le Coup de Bélier et Spécialement sur le Mémoire et les Expériences du Prof. N. Joukovsky, 1898). M. Goupil. A historical, mathematical review of the theory of water hammer. Ills. 8000 w. Ann d Ponts et Chaussées—Part I, 1907. No. 85604 E + F.

MINING AND METALLURGY

COAL AND COKE.

Blasting.

Shot-Firers, and Evils of Solid Shooting. George Harrison. Remarks on the importance of removing the cause of danger, solid shooting, and the effect of large quantities of powder on some coals. 1400 w. Eng & Min Jour—July 27, 1907. No. 85956.

Coal Washing.

Process of Coal Washing. Samuel Diescher. States the impurities found in coal, and gives the theory of the process of washing, illustrating and describing various devices used, and giving information relating to their operation. 5500 w. Pro Engrs' Soc of W Penn—June, 1907. No. 85720 D.

Modern Methods of Washing Bituminous Coal. Floyd W. Parsons. Explains how washing has made possible the mining of coal containing impurities, and illustrates and describes a modern washing plant. 1500 w. Eng & Min Jour—July 6, 1907. No. 85451.

Description of Washing Plants in Operation. W. G. Wilkins. Describes complete washing plants, including not only the washing machines, but also the breaking, crushing, and coal-handling plants. Discussion. Ills. 4500 W. Pro Engrs' Soc of W Penn—June, 1907. No. 85721 D.

Coke Drawing.

New Machine for Drawing and Loading Coke. W. M. Nixon. Describes a new device which employs drags or hooks of the usual form operated by means of wire rope and winding drums. 3000 w. Eng & Min Jour—July 20, 1907. No. 85844.

Coke-Oven Gases.

See Mechanical Engineering, Combustion Motors.

Deep Mining.

The Atchison Mine at Atchison, Kansas. C. M. Young. A brief illustrated description of the deepest bituminous coal mine in the United States. A three-foot bed worked longwall. 1600 w. Mines & Min—July, 1907. No. 85420 C.

Electricity.

Alternating Current in Coal-Mining Operations. George R. Wood. Considers the advantages of this system, costs of installation and operation, equipment of a central plant, and illustrates and describes recently installed plants. 4000 w. Eng & Min Jour—July 6, 1907. No. 85448.

Some Recent Improvements in the Design of Electric Cables for Collieries. G. G. L. Preece. Read before the Manchester Geol. & Min. Soc. Illustrates and describes the stranded copper conductor, and a new type of cable called "the patent solid three-core bitumen cable." Discussion. 2200 w. Elec Engr, Lond—June 21, 1907. No. 85386 A.

Electric Plants.

Electric Installation at the Cambrian Collieries, Limited. Illustrated detailed description of a plant where electricity has been recently introduced. 2000 w. Col Guard—July 12, 1907. No. 85869 A.

Electric Power Plant at the Cambrian Collieries. Describes the electric plant installed to furnish power for these collieries in South Wales. 1800 w. Engr, Lond—July 5, 1907. No. 85597 A.

Fire Bosses.

Proposed Methods for Supervising Fire Bosses (Vorschläge zur Ueberwachung der Tätigkeit der Wettermänner). Herr Baum. A discussion of the necessity of keeping a strict watch over the fire bosses in coal mines in view of the numerous accidents due to inattention and neglect of duty. Ills. 3500 w. Glückauf—June 22, 1907. No. 85633 D.

Mine Examination.

Examination of a Large Coal Property in the West. Arthur Lakes. Suggestions for preliminary work to determine the value of property. Ills. 1000 w. Min Wld—July 27, 1907. No. 85967.

Mine Gases.

The Causes of Sudden Outbreaks of Gas (Zur Theorie der Plotzlichen Gasausbrüche). Alois Becker. A discussion of the causes of sudden outbreaks of gas in coal mines, evolving a theory based on the accompanying phenomena and supported by numerous examples. 2000 w. Serial. 1st part. Oesterr Zeitschr f Berg u Huttenwesen—June 1, 1907. No. 85636 D.

Mine Inspection.

Coal Mines Inspection in 1906. Digest of the reports of H. M. Inspectors of Mines. 34000 w. Col Guard—July 19, 1907. (Supplement) No. 85980 A.

Mining.

Mining Coal. Lee C. Moore. Gives some of the details of operation of a company producing more than 17,000,000 tons of coal per annum. General discussion. 6000 w. Pro Engrs' Soc of W Penn—June, 1907. No. 85722 D.

Working Flat and Pitching Anthracite Seams. M. S. Hachita. Illustrates and describes methods of development. 2500 w. Eng & Min Jour—July 6, 1907. No. 85453.

New Mexico.

New Development of Coalfields of New Mexico. Edward K. Judd. An illustrated article giving information in regard to the deposits, mine operations, water supply, etc. 1200 w. Eng & Min Jour—July 6, 1907. No. 85449.

Pipe Lines.

Wood versus Iron for Pipe Lines in Coal Mines. John H. Haertter. Shows that wood pipe withstands acid water better than iron, and that the cost of furnishing and laying is about 50 per cent. less. 4500 w. Eng & Min Jour—July 6, 1907. No. 85450.

Rescue Apparatus.

Tests of Breathing Apparatus (Bericht über Versuche mit Atmungsapparaten). Herr Grahn. Gives the results of elaborate tests of various types of breathing apparatus to determine their power of supplying pure air over various periods of time and also to determine their effects on the user. 4200 w. Glückauf—June 22, 1907. No. 85631 D.

A Unique English Rescue Apparatus for Mines. Frank C. Perkins. Illustrated description of the "Pneumatogen," designed by Dr. Fried Böck and Prof. Max Bamburger. 1800 w. Min Rept—July 4, 1907. No. 85433.

First Report of the Royal Commission on Mines. Deals principally with rescue work in collieries. Gives experiments made with various types of apparatus by Dr. Boycott. 4000 w. Col Guard—June 21, 1907. No. 85396 A.

Thick Seams.

Rib Drawing in the Connellsville Coke Region. G. S. Baton. Describes methods adapted to mining thick seams under moderately heavy cover. 1000 w. Mines & Min—July, 1907. No. 85423 C.

Thin Seams.

The Panel Retreating System. S. J. Jennings. Describes an adaptation of the panel system for mining thin seams of anthracite, giving comparative costs of three systems of working. 2500 w. Mines & Min—July, 1907. No. 85418 C.

Ventilation.

Practical Experiments in Coal-Mine Ventilation. W. D. Owens. A summary of a series of tests made for the purpose of investigating disputed points concerning the action of fans. 2000 w. Eng & Min Jour—July 13, 1907. No. 85550.

COPPER.

Assaying.

The Iodometric Determination of Copper. F. A. Gooch and F. H. Heath. A discussion of this method with a study of the conditions in the process and their influence. 2500 w. Am Jour of Sci—July, 1907. No. 85705 D.

Australia.

Australian Copper Deposits. John Plummer. A review of this industry in Australia, showing that while not the largest known producing country, it is becoming an important factor in the world's supply. 1000 w. Min Wld—June 29, 1907. No. 85366.

Colorado River.

Copper Mining on the Colorado River. J. George Hately. Information in regard to this district and its development. Map. 700 w. Min Wld—June 29, 1907. No. 85365.

Electrolytic Process.

The Electrolytic Reduction of Low-Grade Ores. Day Allen Willey. Illustrated description of methods used by the Tacoma Smelting and Refining Company for copper and lead ores. 1200 w. Elec Rev, N Y—July 13, 1907. No. 85535.

The Electrolytic Process of Copper Recovery. Walter Stoeger. Describes a process invented by Dr. St. von Laszczynski. 2000 w. Min Jour—July 6, 1907. Serial. 1st part. No. 85588 A.

Low Grade.

Three Large Low-Grade Copper Camps. Etienne A. Ritter. Concerning the camps of the Boundary District, B. C.; of Bingham, Utah; and of Ely, Nevada. Ills. 1800 w. Min Wld—July 20, 1907. No. 85831.

Mine Waters.

Precipitating Copper from Butte Mine-Water. A. F. Bushnell. An account of the recovery of copper by precipitation, with an illustrated description of the methods used by the East Butte Copper Co. 1000 w. Eng & Min Jour—June 29, 1907. No. 85330.

Ore Deposits.

Some New Points in the Geology of Copper Ores. James F. Kemp. Considers briefly the subjects of secondary enrichment, persistance of ore in depth, and other matters of interest. 2200 w. Can Min Jour—July 15, 1907. No. 85787.

Origin of Copper Impregnations in Sedimentary Rocks. Arthur Lakes. A suggestion to account for such sedimentary impregnations. 500 w. Min Rept—June 27, 1907. No. 85361.

Refinery.

Refinery of Rio Tinto Co., Port Talbot, Wales. Edward Walker. Illustrates and describes new works for the production of copper ingots, wire-bars, and cakes from precipitate and Bessemer bars obtained in Spain. 1000 w. Eng & Min Jour—July 20, 1907. No. 85841.

Schuyler.

The Schuyler Mine. J. H. Granbery. Gives the early history of the first mine operated by Europeans in the United States. A copper mine in New Jersey. 4500 w. Jour Fr Inst—July, 1907. Serial. 1st part. No. 85701 D.

Smelter.

The Humboldt Smelter, Arizona. O. H. Fairchild. Illustration, with description, of a plant for the treatment of both copper and lead ores. 1700 w. Min Rept—July 18, 1907. No. 85820.

Smelting.

Copper-Smelting Practice in the Boundary District, British Columbia. Frederic Keffer. An illustrated article describing the ores, their composition, treatment, and the Greenwood plant, which embodies the latest practice of this district. 2000 w. Engineering Magazine—Aug., 1907. No. 85914 B.

GOLD AND SILVER.

Arizona.

Lead-Silver Deposits of Mowry, Ariz. R. B. Brinsmade. Describes the caving system of mining 80 per cent. of the ore without timbering, the complicated milling, and methods of smelting. Ills. 2500 w. Mines & Min—July, 1907. No. 85417 C.

Black Sands.

The Auriferous Black Sands of California. Dr. David T. Day. Gives the scope and results of the investigation by the United States Geological Survey. 2700 w. Mines & Min—July, 1907. No. 85424 C.

British Columbia.

Peace River Valley District of British Columbia. William Fleet Robertson. A report giving an illustrated description of the country, noting the physical and geological formations, the mineral possibilities of copper, silver and gold ores, etc. 5000 w. B C Min Rec—June, 1907. No. 85964 B.

California.

Geology of the Bodie District, California. R. P. McLaughlin. Describes a district which at one time ranked among the foremost gold districts of California. 1800 w. Min & Sci Pr—June 22, 1907. No. 85364.

The Geology of the Coffee Creek Mining District. Norman S. Stines. Describes this district in Trinity Co., California, and its gold-bearing minerals. 1500 w. Min & Sci Pr—July 6, 1907. No. 85523.

Some Ore Deposits in the Inyo Range, California. John A. Reid. An account of the conditions under which lead and silver are found in this range. Diagrams. 2200 w. Min & Sci Pr—July 20, 1907. No. 85960.

Cyaniding.

Cyanide Practice at the Homestake Mills. F. L. Bosqui. Briefly describes these plants at Lead, South Dakota, and interesting features of the practice. 1800 w. Min & Sci Pr—July 6, 1907. No. 85522.

Dredging.

The Modern Gold Ship. George Ethelbert Walsh. An illustrated description of the work of the gold dredge in California. 1500 w. Sci Am Sup—July 6, 1907. No. 85412.

Gold-Dredging Practice at Ruby, Montana. J. P. Hutchins. An illustrated account of how the Conrey Placer Mining Company has met a series of difficult conditions in handling clayey gravel and boulders. 3000 w. Eng & Min Jour—June 29, 1907. Serial. 1st part. No. 85328.

Great Mines.

The Great Silver and Lead Mines. T. A. Rickard. Information of interest in regard to the greatest producers. Ills. 700 w. Min & Sci Pr—June 22, 1907. No. 85363.

Mexico.

Concluding Notes on Guanajuato. T. A. Rickard. Remarks on native labor, and description of the flood of July, 1905. Ill. 1500 w. Min & Sci Pr—July 20, 1907. No. 85961.

The Mines of La Luz, Guanajuato, Mexico. John A. Church. The present article describes the geology of this district, now being reopened. Map. 4000 w. Eng & Min Jour—July 20, 1907. Serial. 1st part. No. 85840.

The Historic Mines of Proano. Paul W. Meyers. An interesting illustrated account of these old silver mines. 3000 w. Min Wld—July 6, 1907. No. 85475.

Proano, a Famous Mine of Fresnillo, Mexico. John A. Church. Gives the early history, geology and description of a remarkable development of veins which yielded $800,000 annually for 67 years. 1800 w. Eng & Min Jour—July 13, 1907. No. 85547.

Montana.

Granite Bimetallic and Cable Mines of Montana. W. H. Emmons. Describes the geology and ore deposits of the famous Granite Mountain silver mine of the Philipsburg quadrangle in the present number. 3500 w. Ores & Met—July 5, 1907. Serial. 1st part. No. 85432.

Nevada.

The Chipmunk Gold Belt, Nevada. Describes this district. The ores are gold with only a trace of silver, and no base metals have as yet been found in this belt. 800 w. Min Rept—July 4, 1907. No. 85434.

Nova Scotia.

The Gold Mining Industry of Nova Scotia. E. Percy Brown. Reviews the history of this industry in Nova Scotia, showing the clauses that have interfered with the development. 4500 w. Can Min Jour—July 15, 1907. No. 85786.

Peru.

The Silver & Copper-Bearing Veins of Huancavelica, Cerro de Pasco, Peru. Carlos E. Velarde. Describes the geology of this region, the deposits, etc. 2000 w. Min Jour—June 22, 1907. No. 85395 A.

Placers.

Examining a Placer Property. George W. Maynard. Outlines methods and gives an account of an investigation of property in Arizona. 1800 w. Min Wld—July 6, 1907. No. 85474.

Ways of Cleaning Up in Hydraulic Placer Mining. Dennis H. Stovall. Shows how gold and platinum may be lost through carelessness, and gives suggestions as to methods of reducing these losses. 1000 w. Ores & Met—July 20, 1907. No. 85899.

Slimes.

The Filtration of Slime by the Butters Method. E. M. Hamilton. A detailed description of the inception, construction, and method of working of this patent filter. Ills. 3500 w. Min & Sci Pr—June 22, 1907. Serial. 1st part. No. 85362.

Stamp Mill.

A Gold Stamp Mill for Laboratory Testing. Frederick H. Sexton. Describes a stamp mill designed to provide a wide range of adjustment, and suitable for testing ores for the best milling conditions. Ills. 1500 w. Min Wld—July 6, 1907. No. 85479.

Tibet.

The Tibetan Goldfields. Dr. Malcolm Maclaren. Map and information in regard to the gold-bearing area of southwestern Tibet. 4000 w. Min Jour—June 22, 1907. No. 85393 A.

Witwatersrand.

Working Costs of the Mines of the Witwatersrand. Ross E. Browne. Information collected in the course of inspection of mines during 1904 and 1905. 15000 w. Tables and diagrams. Jour S African Assn of Engrs—May, 1907. No. 85378 F.

IRON AND STEEL.

Blast Furnaces.

The Modern American Blast Furnace. Bradley Stoughton. An illustrated article explaining how the modern blast furnace is constructed, how it is charged, and how the blast is supplied and heated. 1800 w. Eng & Min Jour—July 27, 1907. No. 85952.

An Example of Blast Furnace Reconstruction. Illustrated description of the modernized plant of the Richard Heckscher & Sons Company, Swedeland, Pennsylvania. 1500 w. Ir Age—July 25, 1907. No. 85877.

Iron Manufacture in Australia. Illustrated description of the Sandford Ltd. blast furnace, at Lithgow, N. S. W., and its operation. 2500 w. Aust Min Stand —May 29, 1907. No. 85491 B.

Cuba.

Barite Associated with Iron Ore in Pinar del Rio Province, Cuba. Charles Catlett. Describes rather unusual deposits found near the little village of Francisco. 500 w. Bul Am Inst of Min Engrs —July, 1907. No. 85927.

Dry-Air Blast.

Notes on the Gayley Dry-Air Blast-Process. Discussion of the paper by C. A. Meissner. 4500 w. Bul Am Inst of Min Engrs—July, 1907. No. 85922.

Electric Smelting.

The Electrical Smelting of Iron Ore. R. L. Phelps. An illustrated description of the plant installed on the Pitt River, California. 1500 w. Min & Sci Pr—July 20, 1907. No. 85963.

See also Electrical Engineering, Electro-Chemistry.

Furnace Charges.

Calculation of Furnace Charges. Regis Chauvenet. Suggestions, showing how a certain class of problems of this nature can be solved by the simple equations. 1500 w. Min Rept—July 18, 1907. Serial. 1st part. No. 85819.

Lake Superior.

Coleraine District, Mesabi Range. Illustrates and describes a washing plant for low-grade iron ore, and the development of the ore beds. 1800 w. Min Wld —July 6, 1907. No. 85476.

Iron Mining Practice on the Marquette Range. Reginald Meeks. An illustrated account of methods used. The caving system predominates, but milling and the inverted cone methods are also used where conditions require. 1500 w. Eng & Min Jour—June 15, 1907. No. 85046.

The Caving System on the Menominee Range. Reginald Meeks. Describes the low-grade iron ore that must be mined economically, and the block-caving, sub-level, and back-stoping methods used. Ills. 2500 w. Eng & Min Jour—July 20, 1907. No. 85838.

New South Wales.

Iron and Steel Industry of New South Wales. Brief account of the industry and iron ore resources of Australia, with illustrated description of the Eskbank Works. 1200 w. Ir & Coal Trds Rev—July 5, 1907. No. 85599 A.

Piping.

Extract of Report on Methods Used to Avoid Piping in Steel Ingots, as Applied in the Hungarian Government Steel Foundries at Diosgyor. Albert Obholzer. An illustrated account of the Anti-Piping Thermit method and results obtained. 1600 w. Jour Fr Inst—July, 1907. No. 85700 D.

The Influence of the Conditions of Casting on Piping and Segregation, as Shown by Means of Wax Ingots. H. M. Howe, and Bradley Stoughton. Experimental investigations on wax ingots concerning the influence of certain conditions of casting upon the size and condition of the pipe, and the position of the segregation, in steel ingots. Ills. 4800 w. Bul Am Inst of Min Engrs—July, 1907. No. 85921 C.

Piping and Segregation in Steel Ingots. A discussion of the paper of Prof. Howe, presented at the London meeting, July, 1906. 3000 w. Bul Am Inst of Min Engrs—July, 1907. No. 85925.

Rails.

See Railway Engineering, Permanent Way and Equipment.

Rolling Mills.

Notes on Rolling Mill Work. B. H. Reddy. Describes rolls for the production of flats, illustrating a 3-high set of rolls designed by the writer for rolling skelp. 1500 w. Ir Trd Rev—June 27, 1907. No. 85339.

The Riverside Metal Company's New Rolling Mill Plant. Illustrates and describes a new hot and cold rolling mill plant recently installed at Riverside, N. J. 2000 w. Ir Age—July 25, 1907. No. 85879.

Electrically Driven Reversing Rolls at the Hildegardehütte Steel Works (Commande Electrique d'un Laminoir Réversible). G. de Taube. Illustrated description of these works in which the Ilgner system of driving is used. 3500 w. Génie Civil—June 8, 1907. No. 85614 D.

Spain.

A Study of the Iron Ore Deposits of Almeria. Pablo Fabrega. The present article considers mainly the geology of the district. Map. 2000 w. Min Jour—July 6, 1907. Serial. 1st part. No. 85586 A.

Steel Making.

Structural Steel Making. Prof. Charles M. Spofford. Illustrates and describes the essential processes in rail and structural steel making, giving an outline of the history of the iron industry in the United States. Short discussion. 7000 w. No. 65. Pro Brooklyn Engrs' Club—1906—No. 85971 N.

MINING.

Accounts.

A Card System of Mine Accounts. R. S. Handy. Detailed description of method used by the writer. 900 w. Min & Sci Pr—July 13, 1907. No. 85834.

Boreholes.

The Determination by Measurement of the Depth and Direction of Deep Bore Holes (Die Feststellung des Fallens und Streichens von Tiefbohrlöchern durch Messung). Herr Erlinghagen. Discusses the various cases in mining work in which such knowledge is necessary and describes the more important instruments and methods for bore-hole surveying. Ills. Serial. 2 parts. 14000 w. Glückauf—June 8, 1907. No. 85630 each D.

Recent Stratameters and Bore Hole Surveying Instruments (Neuere Stratameter und Bohrlochsniegungsmesser). Dr. Freise. Illustrated description of several instruments recently perfected in Germany. Serial. 2 parts. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 15 and 22, 1907. No. 85637 each D.

Bosnia.

The Mining and Electrical Industry of Dolni Tuzla, Bosnio (Die Montanindustrie und das Elektrizitätswerk von Dolni Tuzla in Bosnien). Franz Poech. Describes the geology of the district, the salt and coal deposits and methods of mining and a generating station which supplies power for the mines and for the town lighting system. Ills. 4000 w. Serial. 2 parts. Zeitschr d Oesterr Ing u Arch Ver —June 21 and 28, 1907. No. 85645 each D.

British Columbia.

Reconnaissance Up West Fork of Kettle River. Horace Evans. The present article describes the country. 1500 w. Min Wld—July 13, 1907. Serial. 1st part. No. 85553.

Caving System.

The Dome of Equilibrium and the Caving System of Mining. Claude T. Rice. Considers methods of support used in underground mining, the caving system, and gives the writer's ideas concerning the dome of equilibrium. 1500 w. Min & Sci Pr—July 20, 1907. No. 85962.

Claim Location.

Re-locating Mineral Lands. Rossiter W. Raymond. A discussion of court decisions bearing on the rights of original locators and re-locators of mineral claims on public lands. 2000 w. Eng & Min Jour—July 20, 1907. No. 85830.

Clausthal.

New Plants in the Clausthal District (Die Neuanlagen der Königlichen Berginspektion zu Clausthal). Herr Schennen. An illustrated description of recent extensions in mining and ore-dressing plants and of mining and milling methods in this important galena-zincblende district in Germany. 7000 w. Glückauf—June 1, 1907. No. 85629 D.

Recent Improvements at the Clausthal Mines. Bergrat Schennen. Trans. from *Glückauf*. The improvements relate to mining, ore dressing, and power generating. Ills. 2000 w. Min Jour—June 22, 1907. Serial. 1st part. No. 85394 A.

Concentration.

The Wilfley Table. Robert H. Richards. Presents a series of tests made with the Wilfley table, to study concentration of galena in presence of quartz. 6000 w. Bul Am Inst of Min Engrs—July, 1907. No. 85928 C.

Electric Hoist.

The Electric Hoist and Its Applications. An illustrated article calling attention to the most recent development of the electric hoist and its applications. 2500 w. Ir Trd Rev—July 18, 1907. No. 85727.

Electric Power.

Electric Power at the Calumet and Hecla. Carl L. C. Fichtel. An account of the adoption of high-tension alternating current to supplant steam throughout the mine and mill. 1500 w. Eng & Min Jour —July 27, 1907. No. 85953.

Under What Circumstances Is Contact with an Electrical Circuit Dangerous (Unter Welchen Umständen ist die Berührung einer Elektrischen Anlage Gefährlich?) Hermann Zipp. Discusses the various sources of danger in electrical plants, particularly with reference to the use of electricity in mines. 4000 w. Serial. 2 parts—June 10 and 25, 1907. No. 85648 each D.

Field Geology.

Suggestions for Field Observations of Ore Deposits. S. F. Emmons. Suggestions bearing on mechanical phenomena, chemical and mineralogical phenomena, economic and commercial conditions. 3500 w. Min & Sci Pr—July 6, 1907. No. 85521.

Lime-Roasting.

Laboratory Experiments in Lime-Roasting a Galena-Concentrate. Discussion of the paper of H. O. Hofman, R. P. Reynolds, and A. E. Wells. 2000 w. Bul Am Inst of Min Engrs—July, 1907. No. 85924.

Locomotive Explosion.

Explosion of Air Locomotive. An illustrated account of the explosion of a compressed air mine locomotive while being charged, with some suggestions as to the probable cause. 2500 w. Mines & Min—July, 1907. No. 85422 C.

Magnetic Separation.

Improved Magnetic Separating Machinery. R. T. Clegg. Illustrates and describes a new form of roaster and magnetic separator, designed by E. Hedburg for the treatment of complex ores containing lead, zinc, copper and iron in combination. 1000 w. Min Wld—July 20, 1907. No. 85832.

Milling.

Milling "Sheet Ground" Ore in Joplin District. Doss Brittain. Illustrates and describes the milling system in general, and some of the large mills. 3000 w. Eng & Min Jour—July 13, 1907. No. 85549.

Mine Lamp.

A Portable Acetylene Mine-Lamp. Edwin O. Dane. Describes this type of lamp as used in Mexican mines. Illus. 500 w. Min & Sci Pr—July 6, 1907. No. 85524.

Prospecting.

Interesting Cases of Misleading Prospecting. George H. Ashley. Deals with cases in eastern coal fields. 1400 w. Min Wld—July 6, 1907. No. 85478.

Raising.

Raising and Enlarging a Shaft (Schachthochbrechen mit Erweiterung von unten nach oben). Herr Herbst. Illustrated description of shaft raising methods at a mine in Germany, with costs. 2000 w. Glückauf—June 22, 1907. No. 85632 D.

Roof Supports.

Concrete Roof Supports. A successful application of concrete to replace timber roof supports in the Shamokin, Pa., region, is illustrated and described. 1500 w. Mines & Min—July, 1907. No. 85421 C.

Shaft Sinking.

Sinking a Shaft Through Quicksand by the Pneumatic Process. Describes difficult shaft sinking near Biwabik, Minn., to open up a rich deposit of iron ore. 2500 w. Eng Rec—July 13, 1907. No. 85543.

Smelter Smoke.

The Disposal of Smelter Smoke. Herbert Lang. Suggestions that smoke be conveyed by flue to remote places where it will be harmless. 2500 w. Eng & Min Jour—June 29, 1907. No. 85329.

South Wales.

Mining and Metallurgy in South Wales. Edward Walker. An account of this district, its coal deposits, copper smelting, lead and nickel ores, etc. Map. 1800 w. Eng & Min Jour—July 13, 1907. No. 85548.

Stoping.

Stoping with the Air-Hammer Drill. G. E. Wolcott. Gives a record of experience in stoping and other mine work with the air-hammer drill at Cripple Creek. 1500 w. Eng & Min Jour—July 20, 1907. No. 85843.

Surveying.

Some Practical Points on Mine Surveying. Laurence C. Hodson. Suggestions for work under the conditions often met with in mines. 2000 w. Eng & Min Jour—July 20, 1907. No. 85842.

The Verschoyle Pocket Transit. W. Denham Verschoyle. An illustrated description of this instrument. 600 w. Bul Am Inst of Min Engrs—July, 1907. No. 85926.

Tunnels.

Western Practice in Tunnel Driving. W. P. J. Dinsmoor. Illustrates and describes the methods employed in driving the Ophelia Tunnel in the Cripple Creek District. 2000 w. Min Rept—July 11, 1907. No. 85551.

Cripple Creek Drainage Tunnel Started. An account of the inauguration ceremonies. 1500 w. Mines & Min—July, 1907. No. 85419 C.

MISCELLANY.

Ancient Britain.

The Mines and Agriculture of Roman Britain. Alexander Del Mar. An account of the ancient system of mining, agriculture, and highway construction. 1500 w. Min & Sci Pr—July 6, 1907. No. 85525.

Oil Fields.

The New Tilbury and Romney Oil Fields of Kent County, Ontario. Eugene Coste. Information in regard to the oil and gas wells of this district, with description of the geology. 2500 w. Can Min Jour—July 15, 1907. No. 85785.

Ore Deposits.

The Genesis of Ores. Horace V. Winchell. Commencement address delivered before the Montana School of Mines. Outlines the prevalent modern theories of the genesis of ore deposits, and calls attention to influences and conditions which have a decided bearing upon ore formation. 4800 w. Min & Sci Pr—July 13, 1907. No. 85835.

The Vein-System of the Standard Mine, Bodie, Cal. R. Gilman Brown. Illustrates and describes a very interesting vein-system, within an area of 1,000 ft. by 4,000 ft., having eight or nine successive sets of fissures, five of which are ore-bearing. 4800 w. Bul Am Inst of Min Engrs—July, 1907. No. 85923 C.

Rare Earths.

The Rare Earth Industry (L'Industria delle Terre Rare). V. Fino. Describes the sources of the substances commonly called the rare earths, their industrial applications and method of treatment. 4000 w. Industria—June 9, 1907. No. 85624 D.

Tin.

A Tin Deposit Near Spokane. A. R. Whitman. Brief note giving information bearing on the economic importance of this deposit. 600 w. Min & Sci Pr—July 13, 1907. No. 85833.

The Bischoff Tin Mining Co. James Lewis. A report on the possibility of reducing working costs without reducing the proportion of tin saved. 5000 w. Aust Min Stand—May 22 and 29, 1907. Serial. 2 parts. No. 85490 each B.

Mount Bischoff Tin Mine, Tasmania. Ralph Stokes. A report aiming to explain the circumstances leading to the recent partial collapse and to give a description of the natural conditions and working methods. Ills. 3300 w. Min Wld—July 13, 1907. No. 85552.

Vanadium.

Vanadium in Peru. Jose J. Bravo. A preliminary report on the vandiferous region of Minasragra. 1200 w. Min Wld —July 6, 1907. No. 85477.

Zinc.

The Zinc Belt of Claiborne and Union Counties, Tennessee. W. C. Clarke. Describes formations of varying richness which present a promising outlook. 1500 w. Mines & Min—July, 1907. No. 85425 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Collision.

The Elliot Junction Collision. Information from the report on the disastrous rear-end collision in Scotland on Dec. 29, 1906. 2000 w. R R Gaz—July 5, 1907. No. 85468.

Safety Appliances.

Railway Safety Appliances in America. A review of the annual report of the Interstate Commerce Commission. 2200 w. Engr, Lond—June 28, 1907. No. 85506 A.

MOTIVE POWER AND EQUIPMENT.

Cars.

All Steel Passenger Cars. Drawings and description of the general structure of postal cars, and suburban passenger cars. 1400 w. Am Engr & R R Jour—July, 1907. No. 85409 C.

Invalid and Family Compartment Cars for the London & Northwestern. Illustrated detailed description of recently completed cars. 600 w. Ry Age—July 12, 1907. No. 85554.

Car Heating.

See Mechanical Engineering, Heating and Cooling.

Locomotive Boilers.

The Expansion Stresses in Locomotive Boilers. F. Douglas Wilkes. Points out the direct cause of leakage, giving his opinion of how the difficulty may be overcome, or to a great extent lessened. Ills. 1500 w. Boiler Maker—July, 1907. No. 85357.

Locomotive Boilers in 1834. Illustrates the type of locomotive used on the Liverpool & Manchester Ry. compared with one of the largest and most powerful modern American locomotives. 1500 w. Boiler Maker—July, 1907. No. 85354.

Effect of Scale on the Transmission of Heat Through Locomotive Boiler Tubes. Edward C. Schmidt and John M. Snodgrass. Reports four series of tests to determine the relative conductivities for heat of clean and scale-covered locomotive boiler heating surfaces. 3800 w. Bul Univ of Ill—April 1, 1907. No. 85822 N.

Locomotives.

Ulster & Delaware Ten-Wheeler. Illustrated description of a ten-wheel (4-6-0) simple engine. 400 w. Ry & Loc Engng—July, 1907. No. 85428 C.

A Remarkable Locomotive. Charles S. Lake. Illustration, with description of the new Pacific (4-6-2) type for the Pennsylvania lines. 900 w. Mech Engr—July 13, 1907. No. 85857 A.

Ten-Wheel Locomotive for the Chicago & North-Western. Illustrates and describes engines equipped with the Walschaert valve gear, designed for all-around freight service. 1200 w. R R Gaz—July 5, 1907. No. 85465.

Express Passenger Engine, Midland Railway. Plate, illustration and description of the latest type of the Midland Ry. simple express passenger Belpaire engine of the 4-4-0 type. 700 w. Engr, Lond—July 5, 1907. No. 85598 A.

Four-Cylinder Compound Express Locomotive; Danish State Railways. Two-page plate and further particulars of the "Atlantic" type locomotive, designed by O. Busse. 1700 w. Engng—June 28, 1907. No. 85501 A.

Passenger Locomotive for the Duchy of Oldenburg Railroads. An illustrated description of an engine of the 4-4-0 type, the 5,000th locomotive built by the Hannoversche Maschinenbau-Actien-Gesellschaft. 1000 w. R R Gaz—July 19, 1907. No. 85784.

Passenger Locomotives of the 4-4-4 Type with Bar Frames: Bavarian State Railways. Illustration, with description of some notable engines for fast service with heavy passenger trains. 700 w. Eng News—July 25, 1907. No. 85887.

Recently Constructed Italian Locomotives. Charles S. Lake. Photographs and descriptions of recent engines built by the Società Italiana. Ernesto Breda, of Milan. 2000 w. Mech Engr—July 6, 1907. No. 85579.

Locomotive Tests.

Locomotive Road Tests. W. H. Winterrowd, W. L. Scantlin, W. L. Batt, F. A. Schaff. Tests made to determine the relative efficiencies of consolidation locomotives equipped with Walschaert and with the Stephenson valve-gears. Ills. 1000 w. Purdue Engng Rev—1907. No. 85935 N.

Milan Exposition.

Locomotives at the Milan Exposition, 1906 (Die Lokomotiven auf der Mailänder Ausstellung, 1906). Herr Schwarze. The first instalment of the serial illustrates and describes the German exhibits. 3500 w. Serial. 1st part. Glaser's Ann—June 1, 1907. No. 85666 D.

Passenger and Freight Cars at the Milan Exposition, 1906 (Personen- und Güterwagen auf der Mailänder Ausstellung 1906). Herr Messerschmidt. Gives the general characteristics of the exhibits from the various European countries. 2200 w. Glaser's Ann—June 1, 1907. No. 85664 D.

Motor Cars.

Motor Car or Locomotive (Motorwagen oder Lokomotive). Emil Schimanek. Discusses the results of tests made on the Hungarian State Railways to determine the relative economy of motor car and locomotive operation over short hauls. 3000 w. Glaser's Ann—June 15, 1907. No. 85668 D.

The Steam Motor Car Under Test on the Italian State Railways (Le Vetture Automotrice a Vapore in Esperimento sulle Ferrovie dello Stato). Illustrated description of the car and motor. 3000 w. Monit Tech—June 30, 1907. No. 85622 D.

Steam Railway Motor Carriage for India. Illustrated description of recently ordered self-propelled cars for the East Indian Railway Co. 500 w. Engr, Lond—June 28, 1907. No. 85505 A.

Train Lighting.

Storage Battery Developments in Train-Lighting Service. C. R. Gilman. Describes briefly the three principal systems of electric train lighting, with remarks on special features and the care needed. Ills. 2500 w. Ry Age—June 28, 1907. No. 85359.

See also Electrical Engineering, Lighting.

Wheels.

A Traction Wheel with Sinusoidal Tread. Illustrates and describes a wheel invented by Bernhard Beskow, stating the advantages claimed. 800 w. Sci Am—July 13, 1907. No. 85517.

Solid Steel Wheels for Passenger Cars. George L. Fowler. Topical discussion. An interesting account of tests made, and a discussion of the causes of shelling out and of wear. 3000 w. R R Gaz—June 28, 1907. No. 85335.

NEW PROJECTS.

Africa.

The Nile Red Sea Railroad. Harold J. Shepstone. Illustrated account of the building of a $7,000,000 line through a waterless land. 1000 w. Sci Am Sup—July 6, 1907. No. 85416.

Canada.

New Railroad Construction in Canada and the Northwest. Day Allen Willey. Illustrates and describes interesting work in connection with railroad extensions in northwestern Canada. 1000 w. Sci Am—July 6, 1907. No. 85410.

Philippines.

Progress in the Philippines. From a published interview with Charles A. Conant in regard to proposed extensions of the Manila Railway. 1200 w. R R Gaz—July 19, 1907. No. 85781.

Switzerland.

The Bodensee-Toggenburg Railroad (Die Bodensee-Toggenburgbahn). Illustrated description of this line under construction in Switzerland, giving plan and profile, an outline of the difficulties encountered, and description of some of the bridges, viaducts, stations, etc. 4500 w. Serial. 2 parts. Schweiz Bau—June 8 and 15, 1907. No. 85635 each D.

PERMANENT WAY AND BUILDINGS.

Detours.

The Economics of Detour Building—A Comparison Between Wellington and Prof. Webb. Morrell W. Gaines. 1200 w. Ry Age—July 19, 1907. No. 85821.

Rails.

Notes on Recent Rail Design. A letter from P. H. Dudley in regard to developments and experience in rail manufacture within recent years. 1600 w. Eng News—July 25, 1907. No. 85888.

The Rail Situation. J. Kent Smith. Discusses the causes of rail fracture and the value of vanadium and the open-hearth process. 1000 w. Sci Am—July 20, 1907. No. 85740.

The Action Between Wheel and Rail. H. R. A. Mallock. Read before the Engng. Con. of the Inst. of Civ. Engrs. Considers the mutual action between the rails and wheels from the theoretical point of view. Discussion. 2500 w. Elect'n, Lond—June 21, 1907. No. 85392 A.

How May Quality of Steel Rails Be Improved? Henry M. Howe. Remarks on the frequent breakages of Bessemer steel rails, suggesting improvements in process of manufacture to prevent failures. 2800 w. Eng & Min Jour—July 6, 1907. No. 85452.

The Manufacture of Steel Rails. James C. Bayles. A discussion from the view-point of the rail maker, considering the influence of the dry blast in Bessemer steel practice. 3000 w. Cassier's Mag—July, 1907. No. 85709 B.

Mechanical Experiences with Limber and Stiff Rail Sections. P. H. Dudley. Read before the Am. Soc. for Test. Materials. An illustrated article giving valuable information in regard to rails, the physical properties of the metal, etc. 3000 w. Ir Trd Rev—July 4, 1907. No. 85437.

Salt Lake City.

New Station, Yard and Terminal Facilities of the Harriman Lines at Salt Lake City. Description with plans and elevations from the architect's drawings. 2000 w. R R Gaz—July 12, 1907. No. 85514.

Signaling.

Dry Battery for Block Signal Wires. U. J. Fry. Read before the Ry. Tel. Supts.' Assn. A report of satisfactory service with a great saving in cost. 900 w. R R Gaz—July 5, 1907. No. 85470.

New Top-Mast Motor Signal. Illustrated description of a new two-position electric motor signal, known as M-113, being brought out by the General Electric Co. 1000 w. R R Gaz—July 19, 1907. No. 85780.

The Application of Electricity to the Working of Railway Points and Signals. Luis de Moraes Gomes Ferreira. Read at Engng. Con. of the Inst. of Civ. Engrs. Discussion. 2500 w. Elec Engr, Lond—June 21, 1907. No. 85385 A.

Wireless Signaling System for Railroads. Drawings and description of a sectional rail cab and block signal system embodying the invention of Frank W. Prentice. 1500 w. Sci Am Sup—June 29, 1907. No. 85316.

Block Signals in the Cab of the Locomotive. Illustrated description of a mechanical system for repeating block signals in the cab, which is controlled directly by the regular automatic block signals. 1400 w. Sci Am—July 27, 1907. No. 85892.

Stations.

Proposed New Union Passenger Station at Buffalo. Map, plans, illustrations, and description of a proposed union station. 1500 w. R R Gaz—July 5, 1907. No. 85469.

Passenger Station of the International and Great Northern at San Antonio, Tex. Illustration and brief description of an attractive station to cost about $75,000. 400 w. Ry Age—July 26, 1907. No. 85969.

Lausanne Station (La Gare de Lausanne). C. Jambé. A sketch of the development of Lausanne as a railway center and the improvements and extensions made in the yards and station, with a description of further extensions now under way, made necessary by increasing traffic. Ills. Serial. 2 parts. 5200 w. Bull Tech d l Suisse Rom—June 10 and 25, 1907. No. 85610 each D.

Tracks.

Construction of Second Track Accompanied by Reduction of Gradient. H. H. Knowlton. Deals with railroads undergoing these changes, and matters relating to their economical construction. 3000 w. Purdue Engng Rev—1907. No. 85934 N.

The Fortieth St. Track Elevation of the Chicago Junction Ry. Illustrated detailed description of track elevation under unusually difficult conditions. 4000 w. Eng Rec—July 13, 1907. No. 85537.

Turntables.

Turntable Deflection. A. A. Kellogg. Gives a graphical method used by the writer for determining deflection. 800 w. Purdue Engng Rev—1907. No. 85933 N.

TRAFFIC.

Co-operation.

Relations Between Shippers and Railways. Abstract of a recent address by P. W. Coyle, to the industrial traffic managers of the Business Men's League of St. Louis, urging co-operation for the removal of present difficulties. 1400 w. Ry Age—July 26, 1907. No. 85970.

Demurrage.

The Harriman Lines and Reciprocal Demurrage. Gives a copy of the letter addressed to officers and agents of the Union Pacific, signed by A. L. Mohler, Vice-President and General Manager of the Lines East of Green River. 3000 w. R R Gaz—July 19, 1907. No. 85782.

Rates.

German Export Railway Rates. Information from a recently issued report. 2200 w. Engng—July 12, 1907. No. 85873 A.

Train Loads.

Heavy Freight Trains. Editorial on the growth of car capacity, train loads, etc. 1800 w. R R Gaz—July 12, 1907. No. 85512.

MISCELLANY.

Government Control.

See Industrial Economy.

Holland.

Reorganization and State Exploitation of Railways (Reorganisatie en Staatsexploitatie van Spoorwegen). T. Sanders. A discussion of government ownership in Holland. Ills. 12000 w. De Ingenieur—June 8, 1907. No. 85690 D.

Legislation.

The New Haven-Boston & Maine Anti-Merger Law. Editorial discussion of the anti-merger bill and the present situation. 1200 w. R R Gaz—July 12, 1907. No. 85511.

STREET AND ELECTRIC RAILWAYS

Canada.

Electric Railway Development in Eastern Canada. Patrick Dubee. Read before the Canadian St. Ry. Assn. Remarks on the operation of electric railways in a country where climatic conditions are severe in the winter months. 900 w. St Ry Jour—July 6, 1907. No. 85446.

Cars.

Pacific Electric Passenger Cars. Illustrates and describes various types of rolling stock operated by the Pacific Electric Railway Co. of Los Angeles, Cal. 1000 w. Elec Ry Rev—July 20, 1907. No. 85818.

Conductors.

Experimental Determinations of Physical Properties for the Calculation of Alternating-Current Railway Conductors (Experimentelle Bestimmungen der für die Berechnung von Wechselstrombahn-Leiteranlagen Maszgebenden Physikalischen Gröszen). Leo Lichtenstein. Enumerates the tests that should be made and describes the experiments and results obtained on the Marienfelde-Zossen Railway. Ills. 12500 w. Serial. 2 parts. Elektrotech Zeitschr—June 20 and 27, 1907. No. 85687 each D.

Costs.

The Operating Costs and Revenue of Urban Railways. Gerard B. Werner. Gives an analysis of the last annual report of the Interborough Rapid Transit Company of New York City. 2000 w. Engineering Magazine—Aug., 1907. No. 85915 B.

Efficiency.

Relation Between Maintenance of Track and Equipment of Interurban Lines. W. R. W. Griffin. Read before the N. Y. State St. Ry. Assn. An analysis showing that good tracks greatly extend the time of renewal of cars and electrical equipment. 500 w. St Ry Jour—June 29, 1907. No. 85370.

The Effect of the Transmission Line Upon the Reliability and Efficiency of Electric Interurban Railway Service. E. R. Cunningham. Discusses the methods of connecting the transformers and starting the rotary converters in the sub-stations so that a loss of one, or even two, of the transmission wires will not interrupt the service. Also other details affecting the reliability and efficiency. 2500 w. St Ry Jour—July 6, 1907. No. 85444.

Notes on Tramway Wear and Maintenance. C. F. Wike. Read before the Incor. Assn. of Munic. & Co. Engrs. Gives particulars as to the Sheffield tramways. Ills. 2000 w. Tram & Ry Wld—July 4, 1907. No. 85853 B.

Electrification.

A. C. Electrification on the Illinois Traction System. John R. Hewitt. Illustrates and describes the extensive a. c. single-phase lines recently completed and those under construction, with the apparatus employed in their operation. 5500 w. St Ry Jour—July 6, 1907. No. 85443.

The Introduction of Electric Traction on the Berlin City, Belt Line, and Suburban Railways (Die Einführung des Elektrischen Zugbetriebes auf den Berliner Stadt-, Ring- und Vorortbahnen). W. Reichel. An exhaustive consideration of the problem of applying electric traction to lines at present operated by steam. Ills. 6000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—June 22, 1907. No. 85678 D.

Equipment.

Freight and Miscellaneous Equipment of the Pacific Electric Company. An illustrated description of the freight equipment and miscellaneous rolling stock. 900 w. Elec Ry Rev—July 27, 1907. No. 85966.

Standardization of Electric Railway Equipment. C. B. King. Read before the Canadian St. Ry. Assn. Discusses the wearing parts that could be standardized and so facilitate repairs and lessen expenses. 2500 w. St Ry Jour—July 6, 1907. No. 85445.

Extension.

Ocean City Extension of the Atlantic City & Shore Railroad. Illustrated detailed description of this new line, recently opened. 1000 w. Elec Ry Rev—July 6, 1907. No. 85440.

Hague.

The Hague Tramway Company (Het Bedrijf der Haagsche Tramweg-Maatschappij). E. F. Suringar. An illustrated description of the generating station, tracks, rolling stock, etc., of the Hague municipal tramway. 6500 w. De Ingenieure—June 22, 1907. No. 85691 D.

Interurban.

The Plans of the Boston and Eastern Electric Railroad. Gives an abstract of plans submitted for the building of a high-speed interurban railroad. 5000 w. St Ry Jour—July 13, 1907. No. 85531.

Italy.

Tests of Electric Traction on Italian Railways (Les Essais de Traction Electrique sur les Chemins de Fer Italiens). Philippe Tajani. Discusses the importance of the immense water powers of

Italy, progress in the electrification of steam railroads, state regulation, etc. 8000 w. Rev Inter Econ—June, 1907. No. 85608 H.

Motors.

Motors for Railway Service. Explains the difference between torque and horse-power, the relation between the speed of the motor shaft and the speed of the car, etc. 1400 w. Ry & Loc Engng—July, 1907. No. 85430 C.

Mountain.

The Modern Mountaineer. Information in regard to the proposed Matterhorn railway, illustrating the type of car which will be used on the lower slopes. 1200 w. Ry & Loc Engng—July, 1907. No. 85426 C.

N. Y. Central.

The New York Central's Electric Lines. Map, illustrations and general information in regard to these lines and the service, especially between Little Falls and Syracuse. 2000 w. R R Gaz—July 19, 1907. No. 85783.

Ontario.

Electric Railway Development in Ontario. R. J. Clark. Read before the Canadian St. Ry. Assn. Statistics showing the general progress, with historical details of early lines. 1200 w. St Ry Jour—July 6, 1907. No. 85447.

Power Plants.

The Power Plant of the Norfolk & Portsmouth Traction Co. Illustrated detailed description of a thoroughly modern plant which will furnish power to operate a number of electric railways. 3000 w. Eng Rec—July 6, 1907. No. 85454.

The Steam Power Station of the Twin City Rapid Transit Company, Minneapolis. Illustrated description of a steam-driven electrical generating station having a normal rated capacity of 35000 h.p. and an overload capacity of 50000 h.p. 3500 w. St Ry Jour—July 27, 1907. No. 85949.

The Power Plant of the Norfolk & Portsmouth Traction Company. A new generating station at Norfolk, Va., with a capacity of 10,500 kw., made up of a 1,500-kw. and three 3,000-kw. turbo-generator units, and modern in all the details of its design is illustrated and described. 2500 w. St Ry Jour—July 13, 1907. No. 85530.

New Turbine Generating Station of the Illinois Traction System at Peoria, Ill. Illustrated description of the interesting features of this station. The method of handling the coal and ashes, the vertical machinery in the turbine room, etc. 1500 w. St Ry Jour—July 20, 1907. No. 85830.

Shops.

Shops and Shop Practice of the Los Angeles Railway. An illustrated article describing the new shops and storage buildings and outlining some of the interesting shop methods. 3000 w. Elec Ry Rev—July 6, 1907. No. 85439.

Some Notes on Electric Railway Shops and Shop Practice in Central New York. W. H. Collins. Read before the N. Y. State Ry. Assn. Pronounces the shops very inadequate, lacking suitable tools and sufficient room. 1000 w. St Ry Jour—June 29, 1907. No. 85367.

Single Phase.

The Single-Phase Motor and City Trolleys. Walter I. Tamlyn. Discusses briefly the requirements of city service, giving reasons why the single-phase motor is not likely to replace the direct-current type. 1000 w. Elec Rev, N Y—July 27, 1907. No. 85951.

Third-Rail.

New York, Auburn and Lansing Railroad. A third-rail line for general freight business and passenger traffic, now under construction, is illustrated and described. 2800 w. Elec Ry Rev—July 13, 1907. No. 85562.

Three-Phase.

Notes on Three-Phase Traction. Gerard B. Werner. From a paper read before the Elec. Engng. Soc. of Columbia Univ. Explains structural features of the three-phase locomotive, speed control, and other matters of interest. 1800 w. Elec Rev, N Y—July 20, 1907. No. 85836.

Trunk Lines.

Electric Trunk Line Operation on Lines with Heavy Grades (Elektrischer Betrieb auf Vollbahnstrecken mit Starken Steigungen). Herr Mühlmann. Discusses experiences on the mountain lines of the Würtemberg State Railways. Ills. 3300 w. Glaser's Ann—June 15, 1907. No. 85667 D.

Tube Railways.

The Saint-Michel Station of the Paris Metropolitan. Brief illustrated description of the method of construction in connection with building a tube under the Seine. 2000 w. Sci Am Sup—July 20, 1907. No. 85744.

Charing Cross, Euston, and Hampstead Railway. Illustrates and describes this recently completed line, and giving information concerning the undertaking of the Underground Railways Co. Also editorial. 6000 w. Tram & Ry Wld—July 4, 1907. No. 85852 B.

The Baker St.-Waterloo Tube Railway in London (Ueber die Baker Street-Waterloo Tunnel-Röhrenbahn in London). E. A. Ziffer. Illustrated description of tube, stations, cars, etc. 3500 w. Mitt d Ver f d Förd d Lokal u Straszenbahnwesens—June, 1907. No. 85694 F.

EXPLANATORY NOTE- THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Fôrderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.*- Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr.,f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

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IMPROVED MACHINERY

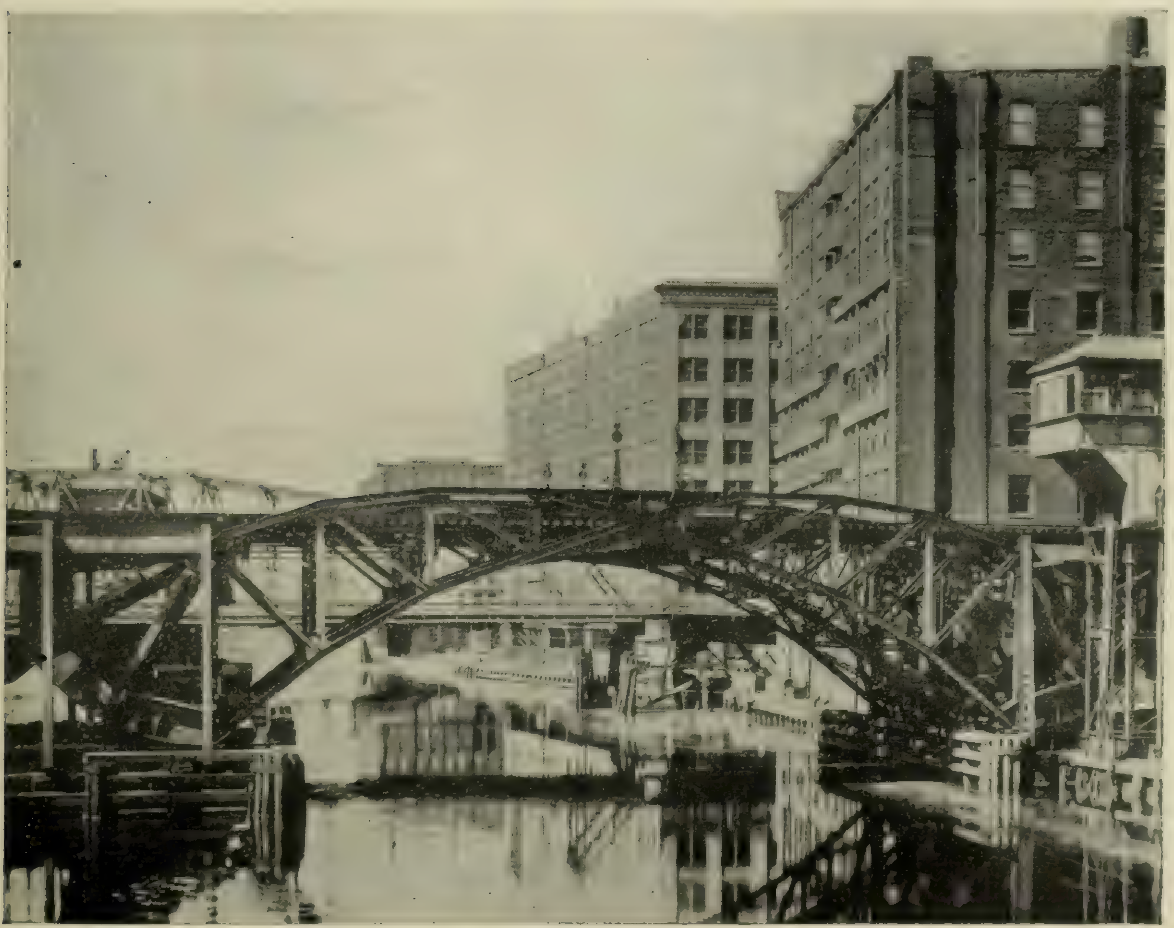
New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Scherzer Rolling Lift Bridges.

IN no field of engineering activity has there been more remarkable progress in recent years than in that of railway transportation. The giant locomotive and the eighty-thousand-pound freight car, like the Leviathan steamship, have become modern symbols of efficiency, economy, and speed. This is obviously because American railway engineers and managers have established a world-wide reputation for progressiveness, through their wide-awake policy of promptly investigating and readily adopting every new device which insures an increase in the efficiency, safety, and economy of their operations. And a striking example of this progressive policy is presented in the comparatively recent introduction, and already widespread use, of the Scherzer Rolling Lift Bridge, which we have pleasure in presenting to our readers.

The first of these bridges was completed at Chicago in 1895, for the Metropolitan Elevated Railroad Company; and it proved to be such an instant and complete success, that numerous other like bridges were at once ordered for many of the crossings in and about Chicago at points where traffic is heaviest. Thus, the device has become the key to the transportation



SCHERZER ROLLING LIFT BRIDGE ACROSS CHICAGO RIVER, CHICAGO, ILL.—BRIDGE CLOSED.

system at this great center, where railway traffic and street traffic are enormous in volume, and where both meet and interchange with an equally enormous lake and canal traffic.

A study of the two illustrations here presented will enable the reader to see at a glance just why the introduction of this bridge marks a new era in the progress of movable bridge science. It will be observed that the structure is what may be termed a "balanced" bridge—that is, the two ends of each span are so nearly balanced in weight that a minimum of power is required to operate the device, instantly and quickly; any available power, be it electricity, steam, or a gas engine, will answer the purpose; and one man can safey operate the plant from either side of the canal or stream.

The entire navigable channel is available, and is unobstructed for the passage of vessels. The span of the bridge may be made either large or small, to fulfill any requirements of navigation, without impairing the simplicity, safety or efficiency of the bridge; and when opened for the passage of vessels, the bridge itself acts as a barrier to close the roadway, and thus absolutely prevents the many serious accidents common to swing bridges when opened.

The complete success of the original four-track Scherzer bridge, built at Chicago in 1895, at once attracted the attention of railway engineers and managers elsewhere, and as a result the New York, New Haven & Hartford Railroad Company promptly ordered a six-track bridge for the entrance to their great Terminal Station in Boston, where six tracks had to be accommodated across Fort Point Channel. If a six-track swing bridge were built, all the tracks would have to be built on one movable structure, and any injury to the structure would tie up the railroad traffic at this important station. With the Scherzer bridge the six tracks could be accommodated by building three double track bridges, side by side, to be operated either jointly or separately, as desired. Injury to one bridge would not interfere with traffic across the remaining bridges. The speed of operation, safety, economy, and efficiency, demonstrated by this first large bridge, induced the same company to decide to remove its center-pier swing bridges at Bridgeport, Westport, Cos Cob, Housatonic River and Connecticut River, in the State of Connecticut; also at the Bronx and Hutchinson Rivers, New York, and the Neponset River, Massachusetts, and replace them all with modern Scherzer bridges, each accommodating four or six tracks, formed of double-track bridges placed side by side. Whenever the traffic of the railroad increases and requires additional parallel tracks and bridges, they can be readily added without interfering with the existing traffic or bridges, as the new structures can be built alongside each other, to carry any number of parallel tracks that may be desired. This advantage is lost when a swing bridge is built. To provide additional tracks, the swing bridge must be removed, at great loss, to be replaced by a new and wider and longer structure.

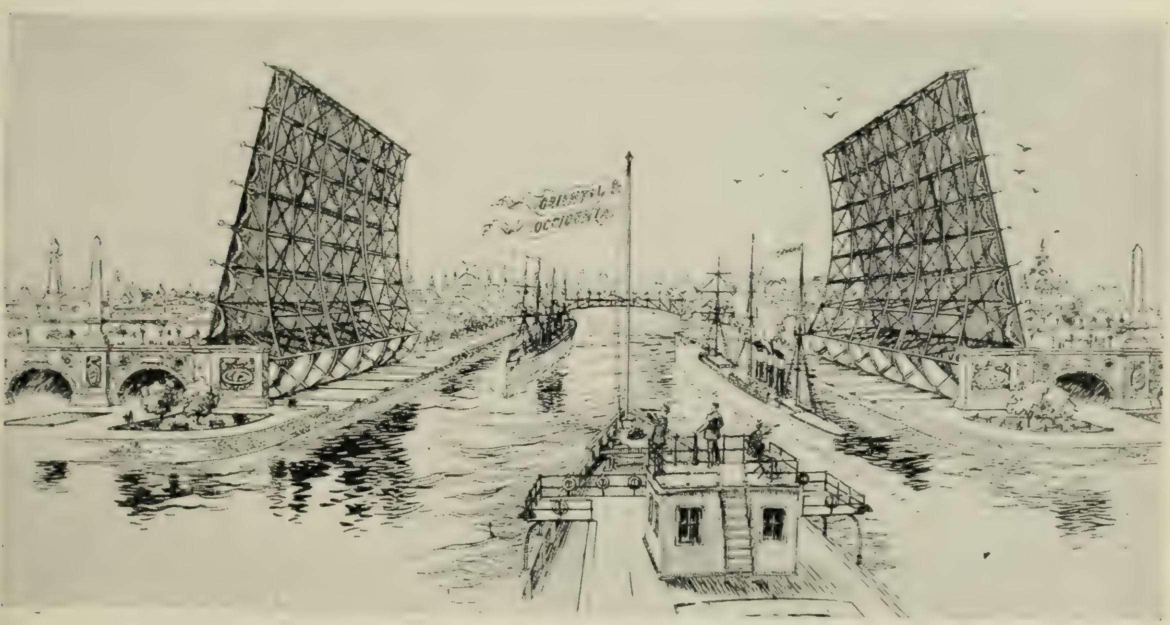
The numerous advantages of the Scherzer bridge were also recognized in 1898 by the interested railroad companies in the adoption and construction of the eight-track bridge of this type, consisting of four double-track bridges, across the Sanitary and Ship Canal at Chicago, instead of a center-pier swing bridge. The companies using this very large bridge are the Pennsylvania lines, the Baltimore & Ohio Railroad, the Chicago Terminal Transfer Railroad and the C. J. Railroad.

The C., C., C. & St. L. Railroad was the first to adopt a Scherzer bridge for construction at Cleveland, Ohio, to supersede a center-pier swing bridge. The success of this bridge soon led to their decision to adopt this modern type of bridge to take the place of their double-track main line bridge, also at Cleveland. The new bridge was constructed and placed in service without requiring a temporary bridge or diverting or delaying the railroad traffic. This could not be accomplished with a swing bridge or any other type of movable bridge. And it was this particular advantage which first attracted the attention of the engineers and management of the Southeastern & Chatham Railroad, England, leading to the adoption of a Scherzer bridge, which has been constructed and placed in successful operation on their main lines across the Swale River, England.

As a result of these demonstrations,

more than sixty additional railroad, electric railway, and highway Scherzer bridges have been constructed, or are in process of construction, in the United States—the principal railroad companies who have ordered them, beyond those mentioned, being the Big Four, the Pennsylvania, the Baltimore & Ohio, the Central of New Jersey, the Norfolk & Western, the New York, Chicago & St. Louis, the Newburgh & South Shore, and many others.

Following the example of American railway engineers, many of the leading foreign railroad companies are also progressively modernizing their lines and adopting the new bridge. The Scherzer bridge across the Suir River, Ireland, for the Fishguard & Rosslare Railways, is nearing completion; the Buenos Ayres Great Southern Railway is building two double-track Scherzer bridges at Buenos Ayres, Argentina; the Dutch Railroad is building a Scherzer bridge across the Spaarne River, Holland, on their Main Line Fast Mail Route, and among recent foreign orders secured are: One by cable from the Government of Khartoum, Egypt, for a duplicate of the large double-track Scherzer bridge built for the Newburgh & South Shore Railroad, Cleveland; also an order from the Burma Railways for a long span Scherzer bridge to be constructed across Ngawun River, India; also an order from Sir Benjamin Baker for the new Buccleugh Bridge, Barrow-in-Furness, England, and substantial progress is being made in the construction of the Walney Island Bridge, England, and the Ekaterinhofka Bridge, Russia.



ENTRANCE TO CHICAGO'S INTERNAL HARBOR SYSTEM—BRIDGE OPEN.

For all of these structures, varying in size and for a wide variety of purposes, the Scherzer Rolling Lift Bridge Company, Monadnock Block, Chicago, furnish the designs, plans and specifications, together with the services of their consulting engineers, for co-operation with the engineers of the various railroad companies, Governments, and municipal corporations.

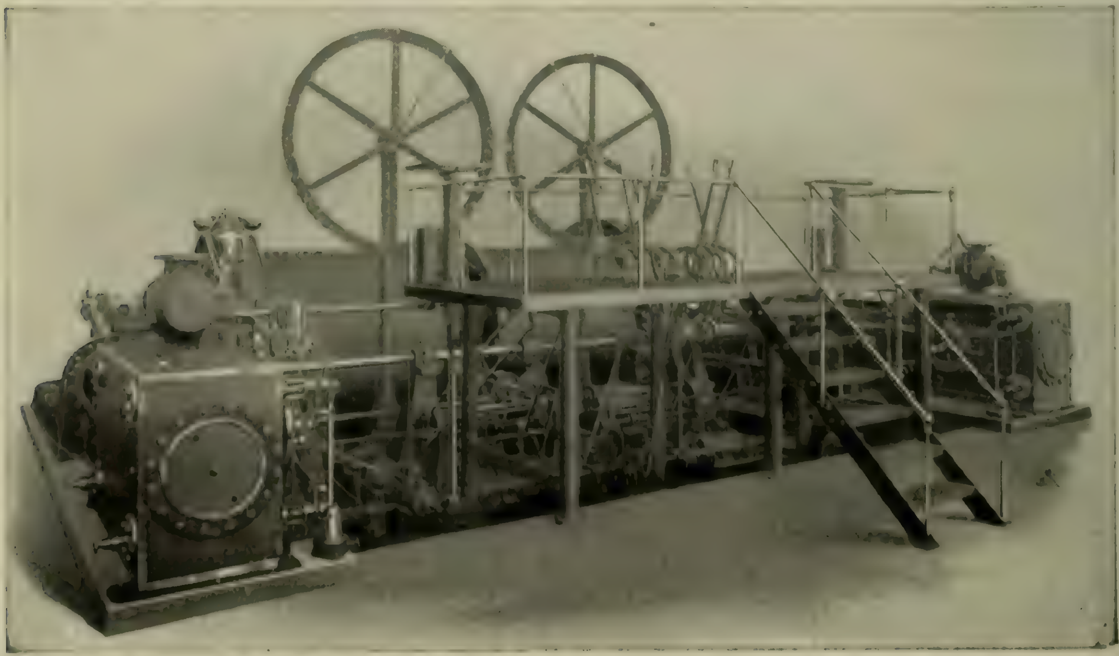
The above record includes the largest and most important railroad, electric railroad, and highway movable bridges constructed throughout the world during the past ten years. It is an unparalleled record, as all the bridges constructed have been eminently successful and have resulted in repeated orders.

The successful solving of the many large and important problems connected with the design and building of so vital a structure as a movable bridge demands the services and extended experience of the highest order of consulting engineering specialists. This is demonstrated by the numerous expensive experiments with swing bridges which have delayed and endangered traffic and in many cases, after only a few years of service, have had to be removed and replaced by modern structures. Attempts at experimental movable bridge construction are especially expensive, one recent instance being a single-track railroad bridge at Cleveland, Ohio. The first cost of this bridge was very high, and it had only been placed in operation a short time when, owing to the complicated character of the structure, the great friction and other faults developed made it unsafe to operate the bridge, compelling the abandonment of all trains in and out of the terminal station and across the bridge for several weeks, while temporary repairs were being made to the bridge.

Safety Appliances on Hoists.

THE Hancock Consolidated Copper Co., whose mines are located at Hancock, Mich., has recently ordered from the Sullivan Machinery Co., Chicago, a hoisting engine to be used for sinking the principal shaft and for permanent service, after the shaft is completed to its final depth of 4,000 feet. This hoist will be of the first motion, heavy duty, Corliss type, with engines 24" diameter by 48" stroke, and two loose drums, 8 feet in diameter by 9 feet long, driven by band friction clutches, and designed for hoisting in balance. The drums will be grooved for 1¼" steel rope, and the maximum hoisting speed under full load will be 3,500 feet per minute. The clutches and band brakes will be steam operated, with automatic compressed air substitution in case the steam pressure falls below a given point, owing to accident or for other reasons.

It will be furnished with the Sullivan patented automatic throttle closing device and interlocking automatic stop. By these contrivances, the steam will be automatically shut off at a fixed distance from the top of the shaft, allowing the engineer to bring the cage to a stop at the desired point, by use of the brake. In case the engineer, for any reason, fails to set the brakes, they will be set automatically at the proper point, to prevent an overwind. This mechanism comprises an automatic throttle-closing device, and an automatic stopping device. Each is driven directly from the drum, and the movable parts work in harmony with the revolutions of the drum. The automatic throttle-closing mechanism is set so that the hoist operates with a wide open throttle until the cage has reached a predetermined point some distance below the surface, at which point the throttle is automatically closed and the cage comes to the landing by the momentum of the moving parts. On account of variation in loads, the cage sometimes fails to reach the dump by a few feet, and a small by-pass throttle is therefore provided, which admits steam between the main throttles and the engines, so that sufficient movement can safely be secured

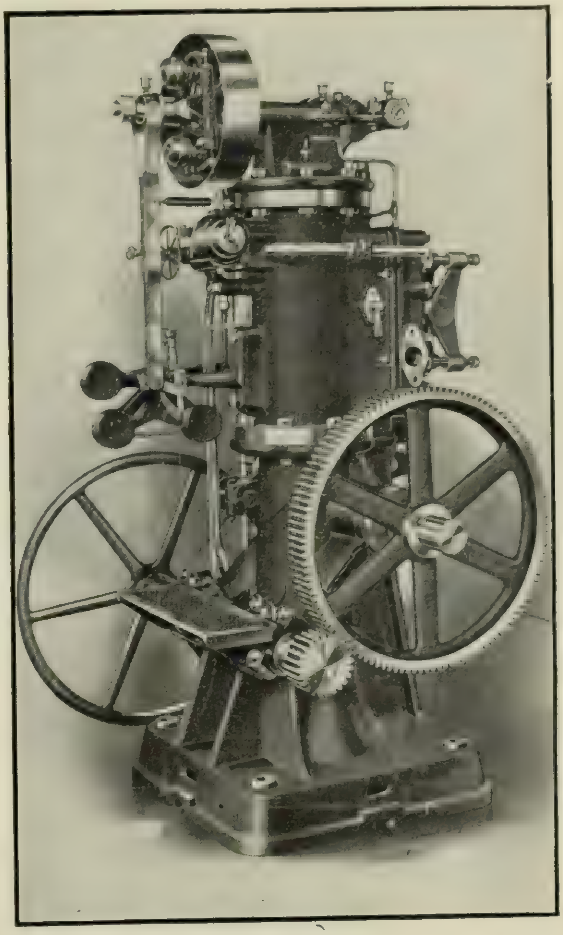


to bring the cage to the landing. This throttle-closing device and the reverse engines are controlled by an interlocking mechanism, making it impossible to open the main throttles until the engine has been reversed for the down trip. An overwind under steam pressure is thus impossible. Without this mechanism the engineer might close the throttles a long time before it was necessary, and feel his way toward the top by the brake, or he might close the throttles too late, making it necessary to bring the hoist to a violent stop.

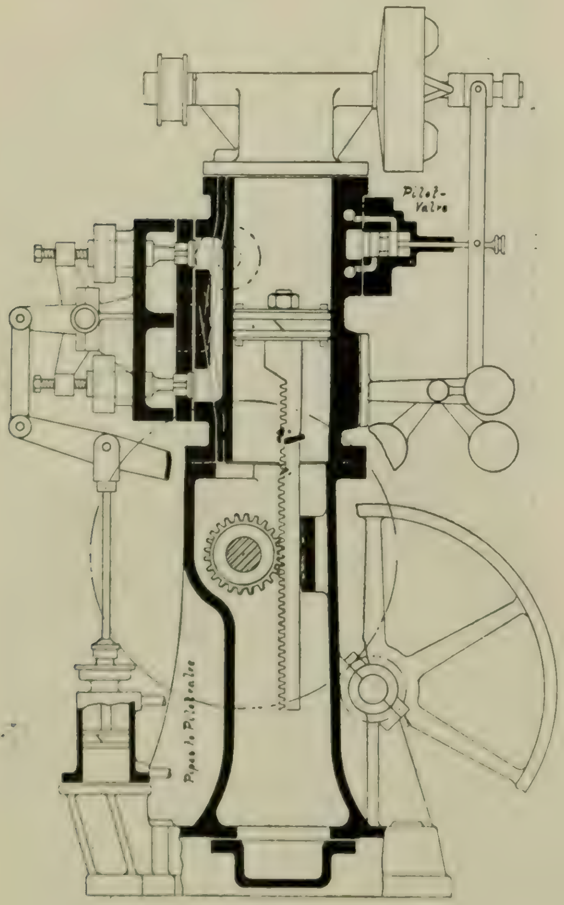
The brake is applied in the usual manner, by means of a lever operating the steam brake engine, but if, for any reason whatever, the cage should go past the dump, the brake is set automatically, bringing the hoist to a standstill almost instantly. When the automatic stop goes into action, the interlocking arrangement locks the mechanism, so that the engineer cannot start the hoist until the stop is replaced by hand. The auxiliary mechanism is very valuable, inasmuch as it permits of high hoisting speed with safety both to machinery and to men. The moving parts are brought to rest by a retardation which is the greatest possible without violent jars, which are so injurious to the ropes and engines, and dangerous to men who are being raised or lowered.

Sturgess Water-Wheel Governor.

CONTINUAL improvement and advancement in hydro-electric plants requires closer regulation of the speed of water wheels. Not only is more accurate regulation demanded, but more strongly built governing apparatus and a higher degree in engineering is required in the layout and relation to the water wheel. A characteristic feature of the type "M" Sturgess governors is that they are capable of continuous service under severe duty with a minimum of care. A second and quite as important consideration is the system of poppet valves for controlling the passage of high-pressure oil to the main cylinder. Piston valves are prone to leak, whatever their form, and even if they have the maximum possible lap, whereas it is found that the cone-seated ground poppet valve remains tight indefinitely. These valves consist of four plain, cone-seated valves, which are lifted off their seats at the right times through the agency of an operating cylinder, the latter being controlled by the centrifugal governor and pilot valve. The seal or surface constituting the joint is practically perfect. If, however, the valves develop a leak through long service they are easily reground with flour emory in a few minutes. The piston valve construction is retained in the pilot valve which controls the operating cylinder. This valve, however, is very small and hardened. The centrifugal governor employed differs from other types in being more powerful as well as more sensitive, and embodies an adjustible feature which is of the greatest importance.



The efficiency of a water wheel governor naturally lies in the centrifugal governor, for on the precision and delicacy of its motions the action of the governor as a whole depends. At times a short deflection and pronounced equilibrium is required, when at other times a large flexible movement gives the best results. The weights and springs are carried on steel knife edges, while the sliding collars have imparted to them a circular as well as a longitudinal movement, the net result being a pure flotation of the balls in the correct position demanded by the speed, and the elimination of internal friction.

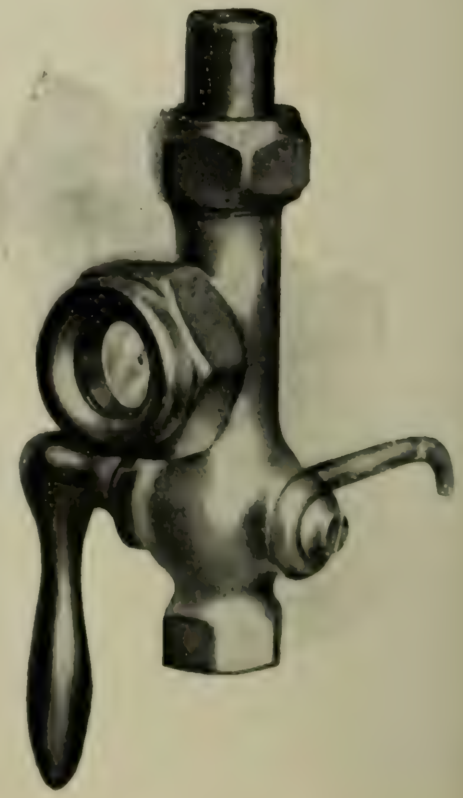


The concealed rack and pinion, by means of which the piston operates the main gate shaft, has the advantages that it is always perfectly lubricated and protected from dust or liability of damage. This rack and pinion, with the shaft, is from two to two and a half times greater than similar parts in other types of governor of the same capacity. Besides a greater strength and area of bearing surfaces obtained, an important benefit arises from the better keying which the larger shaft permits.

The compensator or anti-racing device is of a simple and unique design, which works to perfection. Being made much larger and having a greater degree of motion than similar devices on other governors it is much easier to detect at a glance whether it is working correctly, and is less liable to changes of adjustment due to variations in temperature. This governor is made by the Sturgess Engineering Department, Ludlow Valve Mfg. Co., Troy, N. Y., who will send a bulletin describing this governor on request.

The Multiplus Sight Feed.

THE Multiplus sight feed, which has just been put on the market and is furnished free with all new improved Rochester automatic lubricators, is, as may be seen by the accompanying illustration, a combination sight feed and three way cock. This combination has all the advantages of the sight feed, which enables the engineer to see at a glance whether or not oil is being pumped to the cylinder or point of delivery and it also has the certainty of the three way cock, by means of which the exact amount of oil being fed can be determined by simply turning the handle.



The sight feed is simple in construction, being composed of a chamber, one side of which is a heavy glass disc, against which presses a hollow plunger. In order to pass from the lubricator to the point of delivery, the oil must be forced through this plunger which has an opening in the end.

The oil in forcing its way between the glass and the end of the plunger, moves the plunger back so that only the oil is seen behind the glass, but as soon as the pressure is relieved it resumes its normal position, and the light color of the brass is seen instead of the dark oil. It will thus be seen that when the oil is being fed, that the sight feed will keep up a continual "winking." There is always a solid column of oil under pressure in the Multiplus sight feed and because of this it has the advantage over all glycerine and water sight feeds. Made by Greene, Tweed & Co., New York.

Fire Protection for the Shop.

A LARGE number of factories are so situated that they cannot depend upon the town or city fire department for assistance in case of fire, and even those that are located within a district covered by some fire department are liable to be totally destroyed before help can reach them. The quicker a stream of water can be turned on a blaze the greater are the chances of being able to control it before serious damage is done. This is particularly true of some plants where everything is of an inflammable nature. Insurance rates are necessarily and in many cases prohibitory on this kind of property, but there is a form of insurance whose cost for a lifetime of protection would hardly amount to one or two years of insurance premiums, as a fire pump connected to gas or gasoline engine, or by belt or gearing to water power in order that the pump can be operated independently of other machines; or, better still, connected to an electric motor, if current is available. The discharge may be piped to several fire plugs in different parts of the factory and each plug fitted with a length of hose and a nozzle. Should fire be discovered the pump could be started immediately and within a few minutes one or more streams can be directed upon the blaze. A power pump is preferable for this kind of service as they are not dependent upon the steam pressure in the boiler, which may be too low to operate a steam pump, especially out of business hours, or at night when fires more often occur; and a point of perhaps greater importance is that the power rotary pump is all made of metal, iron body and bronze working parts, so it may stand idle for years and still be in working order immediately as there are no packings or valves to dry out and become useless.

The development of the power rotary fire pump as built by the Goulds Manufacturing Co., of Seneca Falls, N. Y., has brought about many changes and improvements in the past few years and their use for this service is the result of most careful and thorough investigation. Their construction has been carefully considered and they have been subjected to rigid tests by both the manufacturers and users. Rotary power pumps have certain characteristics of the triplex power pumps. They have a triplex or three-toed cam which insures a full continuous intake and delivery with a minimum of power. The peculiar formation of these revolving cams or pistons has proven them to be of such shape as to produce a very minimum of friction and wear with the best results. The cases which receive these cams must necessarily be turned and bored, as they fit into the cases so accurately that when in operation a practically perfect vacuum is created and the pumps will pick up water quicker through a longer distance and hold it better than any other type of fire pump. As mentioned before the method of applying power is of course governed by local conditions. Where water power is available direct connection to water wheel shaft by means of frictional gearing is a very satisfactory arrangement. Other improved methods are geared connection to electric motor, direct connection by coupling to shaft of engine, and where pump and engine are located in an isolated building a belt drive is sometimes satisfactory. A system of stand pipes with valves and hose connections on each floor of the building in connection with automatic sprinklers completes the most perfect equipment for the manufacturing plant, mill or factory. The Goulds rotary pumps are built in various sizes, with capacities ranging from 125 gallons to 1,125 gallons per minute and about 100 pounds pressure on 230 feet elevation.

Swartwout Separators.

THE accompanying illustration is a reproduction of one of three fourteen-inch Swartwout double angle type steam separators recently constructed for the Utah Copper Co., Garfield, Utah, the largest copper smelting plant in the world. These separators are built for a working pressure of 175 pounds and each weighs 3,750 pounds. These three large separators were only a part of the entire order, which included sixteen Swartwout steam separators and two thirty-six-inch Swartwout exhaust heads. The Swartwout productions (separators and exhaust heads) are constructed upon the principle of centrifugal force. In the separator the steam comes in contact with a helical worm, causing it to violently rotate, developing centrifugal force, which hurls the water to the peripheral walls of the separator, when by gravity it is deposited at the bottom of the receiver and escapes through a drip pipe. The exhaust heads operate upon the same principle by forcing or rotating the water from the steam through a helical guide. Further particulars may be had on application to the manufacturers, The Ohio Blower Company, Cleveland, Ohio.

Waterproofing and Masonry.

A PAPER read recently before the Western Society of Engineers, Chicago, by Edward W. DeKnight, contains an exhaustive study of waterproofing, particularly as applicable to masonry and concrete structures. We make some extracts from it:

"Steel-reinforced concrete is yet but an experiment. Nor do we know the life of the modern steel office structure. One thing is sure, that the security and life of its steel skeleton depends upon how far the columns supporting the structure are at their base rotting from electrolysis or moisture. We do not know because we do not see, but that they are decaying is true. While painting exposed steel tends to protect it, paint prevents the bonding of the steel and cement. The life of a masonry structure is indefinite. Imbedding steel in concrete or masonry, however, may or may not be dangerous. We incorporate the steel to strengthen the cement, or the cement to protect the steel—but fail to take the next step forward and protect the cement. What is the natural result? Moisture is readily absorbed by the cement, either by capillarity or through cracks, while the greater affinity of the steel alone would, and does, of itself, draw moisture through two feet of cement. The moisture in passing through the cement takes up certain salts injurious to the steel. We know that steel, imbedded in cement and kept dry, will indefinitely retain its purity and strength. We know also that moisture, reaching the steel, creates corrosion. The immediate effect is to destroy the bond between the steel and the concrete—the heat and expanding gas from decomposition (which is progressive) pressing the cement away from the steel. And there then no longer exists, in fact, steel-reinforced-concrete, but the very opposite—a menace to life and property, which may eventually end in a collapse.

"All efforts in the waterproofing of structural work are divided into two main, totally dissimilar lines: *i. e.:* (1) treating concrete to make it, in itself, impermeable; (2) protecting concrete or masonry with something apart therefrom to waterproof them. In other words,—shall water reach the concrete, or shall it not reach the concrete?

"Under the treatment of concrete to make it, in itself, impermeable come those materials and methods for making concrete impermeable—first, by mixing certain chemicals with the concrete for the purpose of making the solid mass impermeable; and second, by applying a coating or wash to the hardened surface of the concrete, or applying thereto a cement plaster. The ingredients generally used are lime, silicate, soda, lye, soap, alum, etc. Among many objections to the first process is, that the mixing of the chemicals with the cement will not lessen the present general difficulty of having concrete properly mixed in the field. Without or with the chemicals, therefore, there will always exist zones weak in quality and density. Another objection is the uncertain effect the addition of the chemicals will have in time upon the concrete,—and particularly upon the embedded steel. One of the chief, among numerous, objections to the second method, *i. e.,* using coatings or washes, is the poor judgment in basing dependence for permanent waterproofing upon one thickness or layer of any single thing, which in this case happens to be a wash almost imperceptible in its thinness. This aside from any consideration of the fact that but one infinitesimal pore imperfectly closed by permitting the entrance of water, which would soon spread, would make valueless the balance of the washed surface.

"Under the protection of concrete with something apart therefrom to make it waterproof come those materials and methods for preventing water from coming in contact with the concrete. Practically the first efforts in this direction were to coat the surface to be waterproofed with hot coal-tar-pitch or asphalt which, however, when set and cold, cracked and separated with any settling or cracking of the masonry. Burlap was subsequently used to reinforce the pitch or asphalt without, however, preventing them from cracking, and the burlap, being of itself not waterproof did not give waterproofness. Later on there came into use for this purpose tar paper which, however, lacks pliability and tensile strength. Tar and tar paper have been extensively used for waterproofing in the past, simply because there was nothing else open to the profession. It was not until recent years that any serious effort was made to place waterproofing on a scientific basis, and to make materials specially adapted to the various conditions, materials which would not become brittle or be injuriously acted upon by water, the salts in the earth, alkali in cement, etc. The result of this specialization has been to greatly improve methods and to open to the profession products for difficult work and special conditions, considerably in advance of old school materials.

"The best material is unquestionably a strong, fibrous felt, made in itself, *i. e.,* in one sheet, absolutely impervious to water by a process of saturation and coating with materials specially adapted to withstand the injurious action of water, and particularly all underground conditions. It is then practically an impervious membrane or skin through which, of course, in one sheet, water will not pass. As many layers thereof as the conditions require can be then cemented or veneered together with a waterproof bitumen-cement, not too weak, or hard and brittle for the felt, but as strong and elastic as the felt. This forms a waterproof stratum so strong, tough, and pliable that, without injury, it can be readily pulled, bent, turned, twisted, etc. Whether in a building foundation, covering the floor of a bridge or enveloping a tunnel it readily conforms to the final conformation of the surface waterproofed, which it insulates and protects under all conditions—settlement, jars, shocks, cracks, expansion, contraction, heat, snow, ice, water, etc.

"The speaker has termed this 'the membrane method,' and believes it the basis for the development of a perfect waterproofing. Obviously a natural waterproofing is one which skin, hide, or membrane-like, yields to the natural contraction and expansion of the structure, and protects it by preventing water from reaching it."

Mr. DeKnight submitted the following observations and rules for practical application of waterproofing:

(1) No waterproofing, especially for difficult and water-pressure work, should be undertaken when the temperature is below 25° F. Fifty per cent better work can be done when the weather is warm.

(2) Allow sufficient time, room and accommodations in which to properly apply the materials.

(3) Design the structure to receive waterproofing properly. The design will either make impossible proper waterproofing, or will invalidate the best materials after they are in place.

(4) Specify always that the waterproofing shall be done only by experienced and skilled labor. Roofing, for instance, is not waterproofing.

(5) Thoroughly protect the waterproofing during and after application.

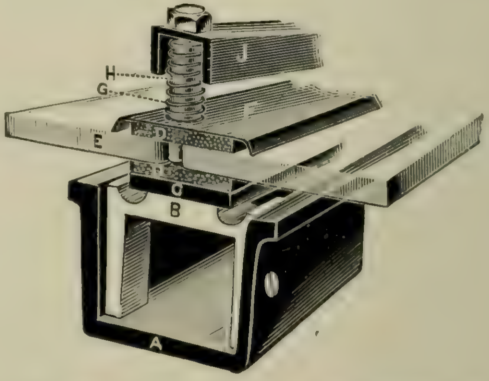
(6) Inspect waterproofing at all times during application. See that the materials as specified are used, and also that they are themselves up to standard; that the work is done carefully and skilfully, particularly in the out-of-the-way small difficult places.

(7) Do not depend on guarantees.

(8) Do not use a set or standard specification. Each design must suit the exact conditions, and each specification must exactly suit the design.

Anti-Pluvius Skylight

THE Anti-pluvius skylight is a German invention, used on some of the largest buildings in Europe. The merits of its construction caused the G. Drouve Company to buy the U. S. patents and place the skylight on the American market about a year and a half ago. In the short time the skylight has been on the market it has been adopted by some of the largest corporations and is now in use on some of our largest buildings, including railroad shops and stations, mills and factories. To give a cursory description of the construction is all we can do here. Referring to the cut, A is the supporting steel channel bar into which are fastened at intervals of 18 or 20 inches malleable iron stirrups B, and into these stirrups are secured solid brass studs H. On top of the stirrup rests a flat iron plate C over which is placed a strip of cowhair felt D; on top of this felt the glass E rests, with another strip of felt on top, thus giving the glass a perfect resting surface without putty or cement. Over the top strip of felt is placed a sheet metal cap F which is held in position by a brass spring G. A shoulder is cut on top of the brass stud and resting on this shoulder is the bridge J for walking on the skylight. It is thus seen that there is always a firm, elastic pressure on the glass to hold it in place and that ample allowance is made for expansion and contraction. Each glass rests independently of every other and never comes in contact with the metal or rigid surface. By means of the bridge J the skylight may be readily repaired or cleaned, broken glass reset, etc., the weight of the man being carried directly by the channel bar A without contact with or pressure on glass. There can be no dripping or condensation, the channel bar serving also as a gutter. Condensation on the glass is cross-guttered into the channel and carried off outside.



The G. Drouve Company, Bridgeport, Conn., are the sole owners and manufacturers of this skylight.

NEWS SUPPLEMENT

The Engineering Magazine—April, 1907

Personal.

—With sincere regret we learn of the recent death of Henry Hoefinghoff, president of the Bickford Drill & Tool Co., Cincinnati.

—Henry I. Lea, who has had considerable to do with the development of the gas producer since 1904, is about to open an office in Chicago as a consulting and contracting gas engineer.

Industrial Notes.

—The Buffalo Forge Co. has changed the location of their Cleveland office from Room 311, Citizens' Building, to Room 618, of the same building.

—Arthur Koppel Co. have moved from their temporary office, 515 Market Street, San Francisco, to their permanent offices at 1509-11 Chronicle Building, San Francisco.

—The name of the Ross Valve Co., Troy, N. Y., has been changed to the Ross Valve Manufacturing Co. The business will be conducted as heretofore by George Ross and his three sons.

—Link-Belt Co. has acquired a new office location at 84 State Street, Boston, from which the future business of its drive chain department in New England will be looked after.

—The Rust Boiler Co., Pittsburgh, Pa., has secured the order for the boilers for the United States Steel Corporation's new plant at Gary, Ind., the order being for sixteen 400 H. P. water tube boilers.

—The Texas Fullers Earth Co., Dallas, has recently awarded the contract for the complete equipment of its plant for dryers, crushers, pulverizers, etc., to the J. R. Alsing Co., New York.

—The International Correspondence Schools, Scranton, has just issued a well-printed book containing the addresses made at the fifteenth anniversary exercises of the School, with photographs of the officers and teachers of the School and speakers.

—Crane Co., Chicago, now have their new steel foundry in full running order. In this department steel valves and fittings will be a specialty, and the facilities are such that promptness in the filling of orders for these goods is assured.

—Sales of Sturtevant generating sets are reported as follows: Richard Borden Mfg. Co., Fall River; Mallory, S. S. Co., Newport News, Va.; Faultless Mfg. Co., St. Charles, Ill.; Eastern Brass & Machine Works, Easton, Pa.

—American Blower Co., Detroit, announce that the addition to their steel plate fan shop is about completed and will be ready for occupancy shortly. The company's architects are now at work on a large addition to their power plant and to their engine construction department.

—The Chicago office of the American Steam Gauge & Valve Mfg. Co., which has been located at No. 16 North Canal Street, has been removed to new and commodious quarters at Nos. 7-9 South Jefferson Street, where they will carry a much larger stock of their staple goods and specialties than ever before.

—The S. Obermayer Co. have let contracts for large improvements for their Cincinnati plant. The improvements will consist of two-story brick building 75 x 75 ft. for manufacturing purposes; also installing 500-horse-power Greenwald Corliss engine, with new improved rope drives.

—The city of Statesville, N. C., has recently purchased three 500 k.w. Allis Chalmers power transformers for use on the Southern Power Company's circuits which supply the city at primary voltages of 40,000, 20,000 and 10,000 volts. The secondary voltages for use in Statesville will be 2300 and 575 volts.

—The Direct Separator Co., Syracuse, have recently arranged with the Dashiell Engineering Co., Atlanta, to handle their specialties in the South, and with J. J. Dwyer, American National Bank Building, St. Paul, to sell their goods in the West, and with A. C. Stansill, Terry Building, for the State of Virginia.

—The Singer Mfg. Co., Elizabethport, N. J., who about a year ago had the Morgan Construction Co., Worcester, remodel their old style gas producers, placing automatic feeds on them, have had such good results that two producers are doing the work that formerly required three. A new 8 x 20 reheating furnace has just been installed and only one additional automatic producer was required.

—Among the rapidly increasing sales of rotary type high pressure blowers reported by the B. F. Sturtevant Co., Boston, are equipments for Union Mfg. Co., New Britain; John Russell Cutlery Co., Turners Falls, Mass.; Greer Filter Co., Hamilton, O.; Hackensack Water Co., New Milford, N. J.; Riverside Boiler Works, Boston; Andrew McLean Co., Passaic; Lumley-Dodson Co., Norfolk, Va.; St. Lawrence Water Co., Massena Springs, N. Y.; and Steamship "Iroquois."

—The advantages of a generating set in which both engine and generator are designed one for the other and manufactured by the same company, are evidenced in recent orders received by the B. B. Sturtevant Co., Boston, as follows: Three sets for the American Dredging Co., Philadelphia; two sets for Newport News S. & D. D. Co., Newport News, Va.; two sets for the Hudson Companies, New York; Pittsfield Street Ry. Co., Pittsfield, Mass.; Louis M. MacDermott, Oakland, Cal.; and Industrial Works, Bay City, Mich.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.

Automobiles.

Association of Licensed Automobile Manufacturers, New York.—A handbook of gasolene automobiles for the information of the public who are interested in their manufacture and use. A most valuable book for one contemplating the purchase of an automobile for pleasure, or commercial purposes, as it illustrates the different cars, trucks, etc., of no less than thirty-nine automobile builders, with dimensions, specifications and prices of all machines. 5½ by 8 in.; pp. 160.

Ball Bearings.

T. H. Symington Co., Baltimore.—Catalogue containing an illustrated description of center and side bearings for steam and electric cars and locomotive tenders. 9 by 7 in.; pp. 24.

Boilers.

Goss Engineering Co., Chicago.—Pamphlet illustrating and describing water tube boilers.

Lyon Brothers Boiler Co., Chicago.—Pamphlet illustrating and describing water tube boilers. 4 by 9 in.; pp. 16.

Cement Making Machinery.

Power and Mining Machinery Co., Cudahy, Wis.—Catalogue No. 2, illustrates and describes machinery for the production of Portland cement by either the wet or dry process. 6 by 9 in.; pp. 86.

Chemists' Supplies.

E. H. Sargent & Co., Chicago.—Cloth-bound catalogue and price list of chemical apparatus and assayers' materials. Fully indexed. 7 by 10 in.; pp. 238.

Clutches.

Akron Clutch Co., Akron.—Booklet containing an illustrated description of friction clutches, together with tables giving dimensions, prices, etc. 3½ by 6 in.; pp. 18.

Coal Handling Machinery.

Jeffrey Manufacturing Co., Columbus.—Bulletin illustrating a number of installations of coal and ashes handling machinery in power plants made by this company. 6 by 9 in.; pp. 16.

Controllers.

Electric Controller & Supply Co., Cleveland.—Bulletin No. 107 treats of type G controllers from 1 to 50 horse-power. Illustrated. 5 by 7½ in.; pp. 18.

Countershafts.

Speed Changing Pulley Co., Indianapolis.—A number of loose sheets describing speed changing transmission countershafts.

Cranes.

Craig Ridgway & Son Co., Coatesville, Pa.—

No. 2 pages 39-46

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

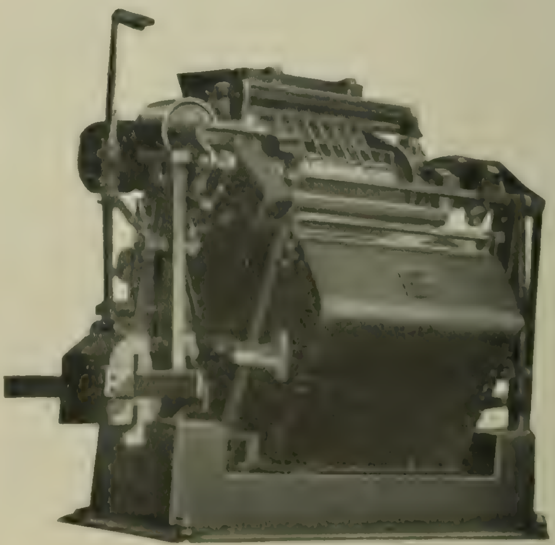
Buffalo Air Washer and Humidifier.

THE attention of architects has been brought most forcibly within the last few years to the great advantages derived from air cleansing when applied to buildings through ventilation systems. A few years ago installations of this character were regarded as curiosities, but within the last few years it has been the custom rather than the exception to provide some means of removing the solid matter held in suspension in the air entering large public or office buildings and fine residences. It is obvious that the need of such devices is most urgent where the fan system of heating and ventilating is used, or where the air is secured through an intake on the level with the pavement, or where smoke or street dust prevails in the atmosphere surrounding a building. It has been discovered that the relative humidity of the atmosphere should be between 50 and 70 per cent., that is, normal to the human body. If 50 per cent. is maintained within a heated building a great saving in the number of percentage required will result. This latter is because lower dry bulb temperature would be necessary to give equal sensible temperature and sense of physical comfort. Therefore, in connection with the problem of air cleansing we might add that the problem of properly humidifying or regulating the moisture content of the air goes hand in hand with the fan system of heating and ventilating. If the methods be reviewed by which air cleansing has been attempted, the development can be traced through cheese cloth screens on wooden frames, coke screens with a trickle of water over them, burlap screens, some wet, some dry, some arranged as a moving belt dipping into a water bath, others stationary with a water trickle or spray playing on them, and finally to the latest water spray and atomizing washers. The objection to cloth filters and coke screens is that they occupy too much space due to the low air velocity which can be allowed owing to the high friction which is imposed in drawing the air through them. Coke screens and burlap belt gives fair results as far as cleansing, but they require much space, and in any event the steam is not automatic and the apparatus must be made to order for the architect—each having his own particular notion as to proportions, etc. It is common with all air cleansers to pass the air taken from the intake through the filter, whatever type may be used, then to the fan and through the heater if it be a "blow-through" type, or through the fan if the arrangement be of the "draw-through" type.

In the Buffalo air washer it is common to pass the air taken from the intake first through tempering coils which in winter raise the temperature 60 to 70 degrees, thus preventing the freezing of water in the washing chamber. The air then enters the washer and is thoroughly sprayed by a system of nozzles ejecting from 2½ to 4 pounds of water per minute in the direction of air travel. The number of nozzles used may be from two to sixteen per square foot of cross section of the washing chamber. Usually the washing chamber is about four feet long, though in special cases where humidity control is of more importance than air cleansing this chamber may be made longer in order to obtain full benefit of the contact between the air and the water surface of the spray. The nozzles used on the Buffalo air washer are of a most peculiar type, in which the water is actually atomized by centrifugal force (due to the construction of the nozzle, which gives the spray a rotating motion) rather than being thrown in flat jets as in other air washers. After the spray water has performed its function of cleansing, moistening or cooling the air, it is necessary that all free particles of water, together with impurities be removed from the air current, yet at the same time no perceptible resistance must be offered to the air passage which will interfere with the ventilation and perfect action of the fan. This is accomplished by the eliminator, which consists of a series of vertical baffle plates, which on the farther edge are provided with little vertical gutters that break the continuity of the water film, and prevent its being blown from the back edge of the plate through the heater. The eliminator plates are galvanized, though in special cases they may be constructed of sheet copper. One great advantage of the eliminator plates used in the Buffalo air washer is that they are fastened together with a steel frame work which keeps them rigidly in shape and preserves the exact spacing required between the plates, not only at the top and bottom, but at intermediate points. The eliminator is self-contained, and when it leaves the factory it is ready to be set in place without any work except that of removing the boxing, a very apparent advantage over any form of eliminator which is composed of loose unsupported parts which are easily bent out of shape. The particular functions of the eliminator may be named as two: first, it presents a water surface to the passing air to which all solid particles not wet down by the spray will adhere; second, the vertical gutters, or lip-like projections, previously described, prevent any free moisture from reaching the fan and being forced on into the building. Though the spray system may be operated directly from city pressure, it is common, except in the smaller sizes, to pump the water over and over until it becomes unfit for use. Rapid evaporation requires a supply of fresh water which is provided by a float valve in the settling tank. A small motor driven centrifugal pump is quite able to supply the necessary pressure and quantity of water required by the sprays.

Automatic Weighing Machines.

THE Automatic Weighing Machine Co. has recently moved into its new building, at Newark, N. J. This company owns about 350 patents pertaining to automatic weighing machines, and the machines are constructed specially for a great variety of users, but perhaps the largest demand for automatic weighing machines from any one industry comes from the cement manufacturer. The special automatic weighing machines used in cement manufacture have been developed by the company in step with the development of that industry.



The automatic weighing machines used by cement makers not only weigh out the manufactured product and deliver it to the bag or barrel into which it is packed for the market, but they also weigh the percentage of limestone, clay, marl or shale stone the manufacturer uses for roasting or grinding. The great usefulness of these machines to the cement manufacturer exists in the fact that no cement can be manufactured by rule of thumb, each consignment of material, whether of clay or rock, must be analyzed and the correct percentage thereof ground up together to make a cement that will stand the tests to which cements must be subjected for all important construction work. These percentages are accurately measured and weighed by the automatic machines when determined by the analysis, the only necessity being that the operator shall fix the pointer on his scale beam to the mark designated.

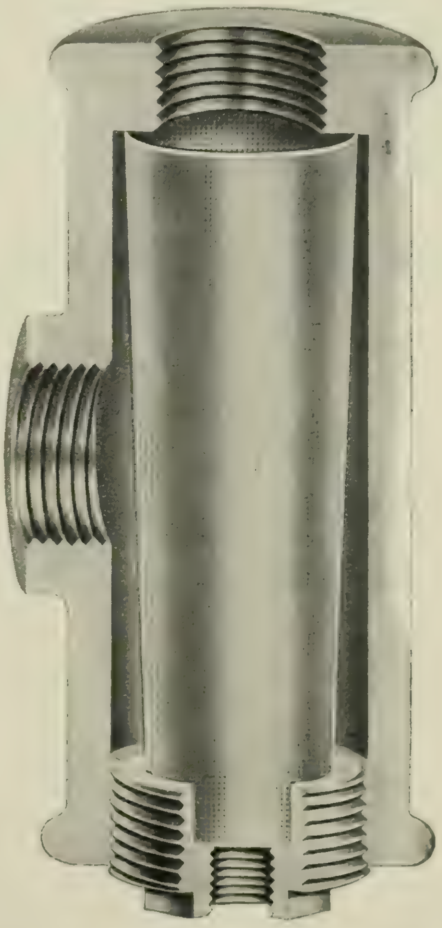
With few exceptions all the machines made by the Automatic Weighing Machine Company are leased to the manufacturer who uses them. The company installs the machines, puts them in running order and maintains them in operation on a royalty basis much as the United Shoe Machine Company leases its machines for the manufacture of boots and shoes. The machines, however, may be purchased outright if the manufacturer so desires.

Interlocking Rubber Tiling.

MUCH of the credit for the enormous increase in popularity of interlocking rubber tiling is due to the Pennsylvania Rubber Company, of Jeannette, Pa., who entered this field with a new and simplified arrangement of interlocking rubber tiles a few years ago. Appreciation of the wide variety of uses to which this material could be successfully applied led the company to exploit its product vigorously, with the result that at present there is scarcely any class of building in which it is not found. Some idea of the scope of its usefulness may be gathered from the fact that it may be seen upon the floor of one of the finest cathedrals in the country, and in one of the largest of the public art galleries, and at the same time in many kitchens, vestibules and bathrooms of the well-to-do. The advantages claimed for this interlocking rubber tiling are so many and general that space does not permit their enumeration, but it is said to outwear even marble, to form an absolutely waterproof surface, and to be so easily applied that any workman of ordinary skill can lay it successfully, though he may be previously inexperienced with it. Ocean liners, lake steamers, ferryboats and yachts are large users of this tiling because of its non-slippery character, and the fact that it remains unaffected by constant wrenching strains. As flooring for elevators it is also popular for the same reasons.

The Wright Filter.

THE accompanying illustration shows the "Wright" filter, a new appliance, at low cost, for the elimination of all foreign matter, such as sand, scale, vegetable and floating substances of minute or large proportions, from water pipes, boilers, meters or any device to which water is fed through pipes. It will be noted that this filter is simple in design, compactly constructed and contains no complications to cause trouble after installation. The outer cylindrical casing contains a circular conical tube screen of much larger area than the opening at inlet. This screen is secure-

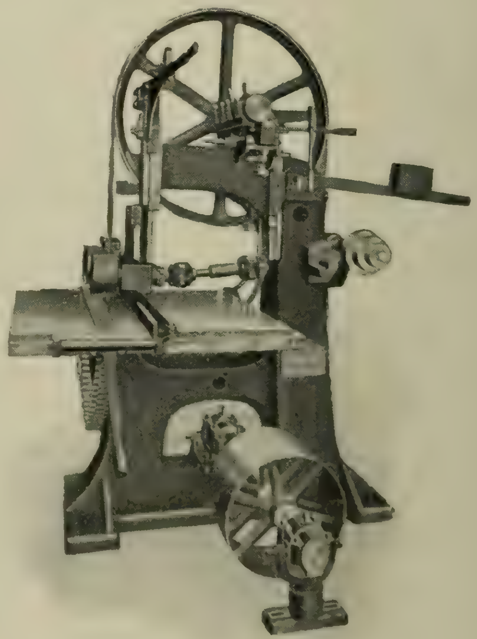


ly fastened to a plug which is screwed into outlet at the lower end of the device and may be removed in an instant by simply unscrewing the plug. A blow-off valve attached to this plug will, if occasionally opened, serve to keep the filter free from accumulated matter which is retained in the screen and precipitated to the bottom thereof.

The manufacturers claim the Wright filter enjoys its present state of efficiency under the original design, but in keeping with customary policy sufficient time has been allowed for many and varied tests to which it has been subjected and in every case the results have proven highly satisfactory. The Wright promises to become popular with institutions requiring the use of a large number of efficient filters at a nominal cost. The filter is made in six sizes, being governed by diameter of inlet pipe and ranging from one to three inches, or special sizes for special purposes. The device is manufactured by the Wright Manufacturing Co., 26 Woodbridge Street, Detroit, Mich.

Combination Band Rip and Edging Saw.

THE accompanying illustration shows a new combination band rip and edging saw. For edging, the table is provided with a traveling chain under the out-feeding roll, as shown in illustration and is operated by a sprocket chain and gearing from the same shaft that runs the upper-feed-rolls. This traveling chain has a vertical adjustment and can be quickly dropped below the surface of the table to be out of the way for ripping. The column is very heavy, cored and perfectly free from vibration. The distance between the fence and the saw blade will admit material up to 24 inches wide. The rolls may be raised to receive timber 12 inches thick. The table is of ample size, and has, at the front, a plainly stamped index. Idler rolls are fitted in the table to remove friction. A cam lever releases, moves and clamps the fence, accomplishing the adjustment of the fence more quickly than by any other means yet devised. The wheels are 42 inches in diameter, entirely of iron and steel, with spokes; the lower, heavy and with solid web, circulating less dust and sustaining great momentum, so that its speed governs that of the upper, preventing the latter overrunning the former. The wheel shafts are of steel, especially heavy, running in extra long self-oiling bearings. The straining device (controlling the upper wheel and the path of the saw blade on the face of the wheels) is new and very sensitive and has a forward, backward and also a side adjustment. It is regulated by an adjustable weight and a compound lever so sensitive that no matter what the vibrations are the strain takes up the slack in the blade instantly, adding wonderfully to the perfect working of the machine and the life of the saw blade. The saw guides are the latest improved pattern with sectional hardwood blocks arranged to permit of taking up the slightest wear and perfectly guiding the blade in the plane of the cut. There are three speeds of feed, 30, 60 and 125 feet per minute. Faster feeds will be furnished when desired. The feed is very powerful, the driven feeding-in and feeding-out rolls placed close together, enabling short stock to be worked to advantage. They are adjustable up and down instantly by means of the long lever above, convenient to the operator, or they may be raised from the board, instantly stopping the feed, or lifted quickly out of the way for use as a hand feed rip saw, all of which may be accomplished by a single

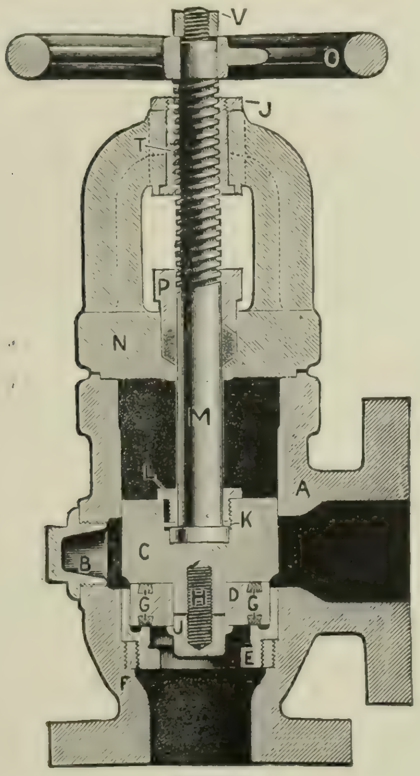


movement of the long lever. The feeding-out roll bearing is adjustable to take up the slack in the driving chain.

For further information regarding this tool, write the manufacturers, J. A. Fay & Egan Co., 212-232 West Front Street, Cincinnati, O.

An Improved Blow-off Valve.

THE cut herewith fully illustrates an improved design of blow-off valve, which embodies a number of important features highly appreciated by users. Heretofore the seat was so located that as the disc approached the same, there would be an accumulation of scale and sediment. The effect of this accumulation would be to cut the bearing surfaces to such an extent that in a short time the valve would become leaky. Various methods have been invented whereby the disc would fit tightly in the valve body, the object being to prevent the scale from passing on to the seat bearing after the disc had passed and cut off the inlet. This method, however, has not proved satisfactory, as the valve would soon wear, and in a short time, permit the passage of scale and sediment. These defects have been overcome in this improved design blow-off valve. The plug fits snugly in a separate and easily removable bronze casing, which can be readily replaced when worn. Any accumulation of scale or sediment that might remain on the seat before the disc is brought in contact with same, is washed off by the water which passes around the plug when seating. It will be seen that the plug C carries a reversible, double-faced disc D, secured to the plug by a stud and nut. This plug is guided perfectly in the valve body. The bronze seat ring is screwed into a second brass ring, F, the object being to make it possible to renew the seat ring very easily when worn. At the back of the valve is a plug, B, the use of which is to permit the introduction of a rod to clean out the blow-off pipe when desirable. The stem which raises and lowers the disc is held in place by lock-nut which is prevented from unscrewing by a non-rotating washer. The threads of the stem operate within the bronze bushing in the top of the yoke, which bushing can easily be removed.



It will be seen from this description that all parts of the valve have been so designed that they can be easily renewed when worn or broken. The disc, having two Babbitt-faced bearings, can be replaced at small cost, or the user of the valve can melt out the old Babbitt and pour in new metal, and after this is faced off, the disc is as good as new. When it is desirable to close the Duro valve in operation, the disc is screwed down in the usual manner. As the edge of disc approaches the cylindrical extension these edges shear and cut off any scale or sediment which might pass. As the disc continues to approach the seat bearing the leakage of water around it will effectually wash off any scale or sediment which might have accumulated. The result of this is that when the disc is perfectly seated no scale or sediment can remain between the bearings. As the seat and disc ring can be removed very easily and at small cost, it will be plain that the valve is very durable and will last indefinitely. This article, known by the trade name of "Duro," is constructed of the very best materials and carefully tested by The Lunkenheimer Company.

Buckets for Handling Broken Stone.

ALMOST every day we read in the technical papers of gigantic engineering works in which thousands of yards of concrete are used, necessitating the handling of large quantities of cement, sand and broken stone. The cement and sand can readily be handled, but the problem of unloading broken stone from cars or barges is not so readily solved. Both the cement makers, using large quantities of broken stone, and the cement users, requiring stone of smaller sizes, are beginning to recognize the value of grab buckets as a means for handling broken stone and sand in a rapid and economic manner. We illustrate here a modern plant, owned and operated by the Cosmos Portland Cement Company of Cosmosdale, Ky., for handling large quantities of stone from barges to storage bins, from which it is spouted into cars as desired. This revolving derrick is of steel construction and is mounted upon a concrete pier as shown. The mast is 92 feet high and the boom 75 feet long. Hoisting and slewing are accomplished by separate engines, the former being an 8″ x 8″ and the latter 6″ x 6″. The rig is equipped with a Jeffrey Class "B" grab bucket, especially designed for handling material of this kind. Another view shows the bucket ready to take its bite, and, as will be noted, the span is large, and the bucket will fill itself to capacity in a shallow depth of material. A third illustration shows the bucket closed and carrying its load to the storage bin. This bucket can unload a thousand ton barge in about ten hours and will handle in a satisfactory manner stone up to 4″ cubes. Stone can also be handled from cars by means of this bucket, 90 per cent. being cleaned up without the least damage to car, no hand shoveling being necessary.

This bucket is of heavy design to withstand the hard usage to which it is subjected. All castings are of steel, all sheaves are machine grooved and have hard bronze bushings. The scoops are of heavy steel, well reinforced with angle braces. The scoops are provided with reinforcing lips, which may be replaced with new ones when worn out. All pins are of cold rolled steel, accurately machined and fitted, the form pins, the only ones liable to abrasion from coming in contact with sand, being of hardened steel running in hard tempered tubing, and show but little wear after a season of hard usage. The Jeffrey Mfg. Co., of Columbus, Ohio, are prepared to build this bucket in any desirable size, and will design, build and erect rigs for the handling of same.

NEWS SUPPLEMENT

The Engineering Magazine—May, 1907

Personal.

—Theodore D. Buhl, president of the Buhl Malleable Co., and the Buhl Stamping Co., Detroit, died recently from apoplexy while in New York.

—J. H. Dohner, for a number of years with the National Cash Register Co., has accepted a position as assistant general superintendent with The National-Acme Manufacturing Co., Cleveland.

—Edward W. De Knight, manager of the Hydrex Felt & Engineering Co., New York, sailed on the S. S. Hamburg, March 30th, on an extended European trip via the Mediterranean.

—E. M. McIlvain, formerly president of the Bethlehem Steel Co., has been elected president and general manager of the Robins Conveying Belt Co., Park Row Building, New York.

—Gardner Cornett has recently been elected vice-president of the American Steam Gauge & Valve Manufacturing Co., his office being located at the headquarters of the company, 220 Camden Street, Boston.

—William S. Johnson, for the past twelve years the assistant engineer of the Massachusetts State Board of Health, announces that he has opened an office at 101 Tremont Street, Boston, for the practice of civil Engineering.

—Robert C. Shaal, formerly with the General Storage Battery Co., New York, has accepted the position of sales engineer of the Bliss Electric Car Lighting Co., with headquarters at the company's New York office, Fifth Avenue and 44th Street.

—F. A. Molitor has resigned the position of supervising railway expert to the Philippine Government, his resignation taking effect April 1st, upon which date he left Manila, P. I., and will return to the United States during the fall, spending the interim in China, British India and on the Continent. After leaving Manila, P. I., Mr. Molitor can be addressed in care of the University Club, Philadelphia.

Industrial Notes.

—The Ball Engine Co., Erie, Pa., builders of automatic and Corliss engines, has opened a branch office at 1213 Chemical Building, St. Louis, under the management of O. L. Collins.

—The Seely-Taylor Co. announces that its business has been merged with a new corporation under the title of Maritime Dredging Co., which will continue the business of the old corporation at 78 Broad St., New York.

—The Ball Engine Co., Erie, Pa., announces that it has opened a branch office at 39 Cortlandt St., New York, for the sale of its automatic and Corliss engines. This office will be under the management of Lancelot Copleston.

—The New Electrical Engineering Building of Worcester Polytechnic Institute, which will be the largest one of its kind in the country, costing over $125,000, is to be equipped with a complete heating and ventilating outfit supplied by The Green Fuel Economizer Co., Matteawan, N. Y.

—B. F. Sturtevant Co., Boston, has just received from the Interborough Rapid Transit Co. a repeat order for standard economizers. The previous order was for the equipment of 26,000 boiler horse power. The total number of tubes to complete both orders will be 11,200.

—The New York branch of the Green Fuel Economizer Co. has removed to the new West Street Building, No. 90 West Street. The new offices will be considerably larger than the old, in order to take care of the increasing business in economizers, fans, blowers and exhausters.

—Sales are reported of Sturtevant high pressure rotary type blowers to Otis Elevator Co., Chicago; The Macallen Co., South Boston; United Oil & Refining Co., Beaumont, Texas; Lumsden & Van Stone Co., Boston; Johnson & Blanding, Providence; and Sharpless Separator Co., West Chester, Pa.

—Alberger Pump Co. has been organized to manufacture and sell centrifugal and turbine pumping machinery embodying novel and important improvements. The main office is located at 95 Liberty St., New York, with a branch office at 205 La Salle St., Chicago.

—The Locke Regulator Co., Salem, Mass., manufacturers of the Locke engine stop and speed limit system, have just won the suit for infringement brought against them by the Consolidated Engine Stop Co. under the "Stannard" patent. No engine stops had ever been manufactured under it. Suit was brought against one of the customers of the Locke Regulator Co.

—The Le Naire Advertising Co. announce their removal to 150 Nassau St., New York, where they will continue to write and design advertisements, circulars, booklets, catalogues and other printed matter for engineering and machinery firms. Lewis T. Le Naire, manager of the above company, has had a wide experience in this kind of advertising.

—The Banning Co., heretofore known as Bruce & Banning, has been incorporated under the laws of the State of New York. The policies and methods of operation will be the same as those employed by the latter company. On May 1st they will move from their present offices to the Brunswick Building, 225 Fifth Ave., New York, where larger quarters have been secured.

—The Crocker-Wheeler Co., whose main office and works are at Ampere, N. J., has found it impossible to handle its rapidly increasing business in electric motors and generators in Birmingham, Ala., from its New Orleans and Baltimore offices, and has been obliged to establish headquarters in Birmingham. The new office which is in the Woodward Building, Birmingham, is in charge of B. A. Schroder, who hitherto has taken care of the New Orleans territory of the company.

—The Cleveland-Cliffs Iron Co. has placed an order for a 60-drill Sullivan air compressor for its new Maas Mine at Negaunee, Mich. The machine will be of the Corliss cross compound condensing two stage type, with large receiver intercooler. The steam cylinders will be 24 x 46 inches in diameter, with a 48-inch stroke, and the air cylinders 40 x 24 x 48 inches, with a displacement capacity of 4,000 cubic feet of free air per minute at 60 R. P. M., or nearly 5,000 feet at 70 R. P. M. The compressor will be built at the Chicago works of the Sullivan Machinery Co.

—The Casualty Co. of America is now writing fly-wheel insurance in addition to its other lines. They are placing on the market an excellent contract covering certain features original with this Company. In addition to the ordinary covering of property, loss of life and personal injuries, they have added the additional features of indemnity daily loss of profit and income as the result of fly-wheel explosions. This very broad policy should enable this Company to obtain a large number of risks in this particular line of casualty insurance.

—Electro Metallurgical Co., with general offices at 157 Michigan Ave., Chicago, and branch offices at 79 Wall St., New York, was incorporated about six months ago, and began the manufacture at Niagara Falls, N. Y., of high-grade ferro-alloys, and at which point they are now installing additional equipment for materially increasing its output. The Willson Aluminum Co.'s works and business have been sold and transferred to the Electro Metallurgical Co., and the latter company are now adding to its Kanawha Falls, W. Va., works with the intention of increasing its capacity and output of ferro-alloys, particularly ferro-chromium and ferro-silicon.

—On May 1st the Chicago branch of Niles-Bement-Pond Co. will occupy their new offices on the sixth floor of the new Commercial National Bank Building, Clark and Adams Streets, Chicago. Pratt & Whitney Co. will abandon their show room and offices at 46-48 South Canal Street, and will combine their machinery sales department with that of Niles-Bement-Pond Co. The show room and stock of Pratt & Whitney small tools, and the small tools sales department, will be located on the ground floor of the new Plamondon Building, Clinton and Monroe Streets, where a complete line of Pratt & Whitney small tools and gauges will be carried in stock. Geo. F. Mills, who has for several years looked after the interests of these companies in the Chicago territory, will continue as manager of the Chicago office.

No. 3 pages 35-47

IMPROVED MACHINERY

New Processes and Appliances

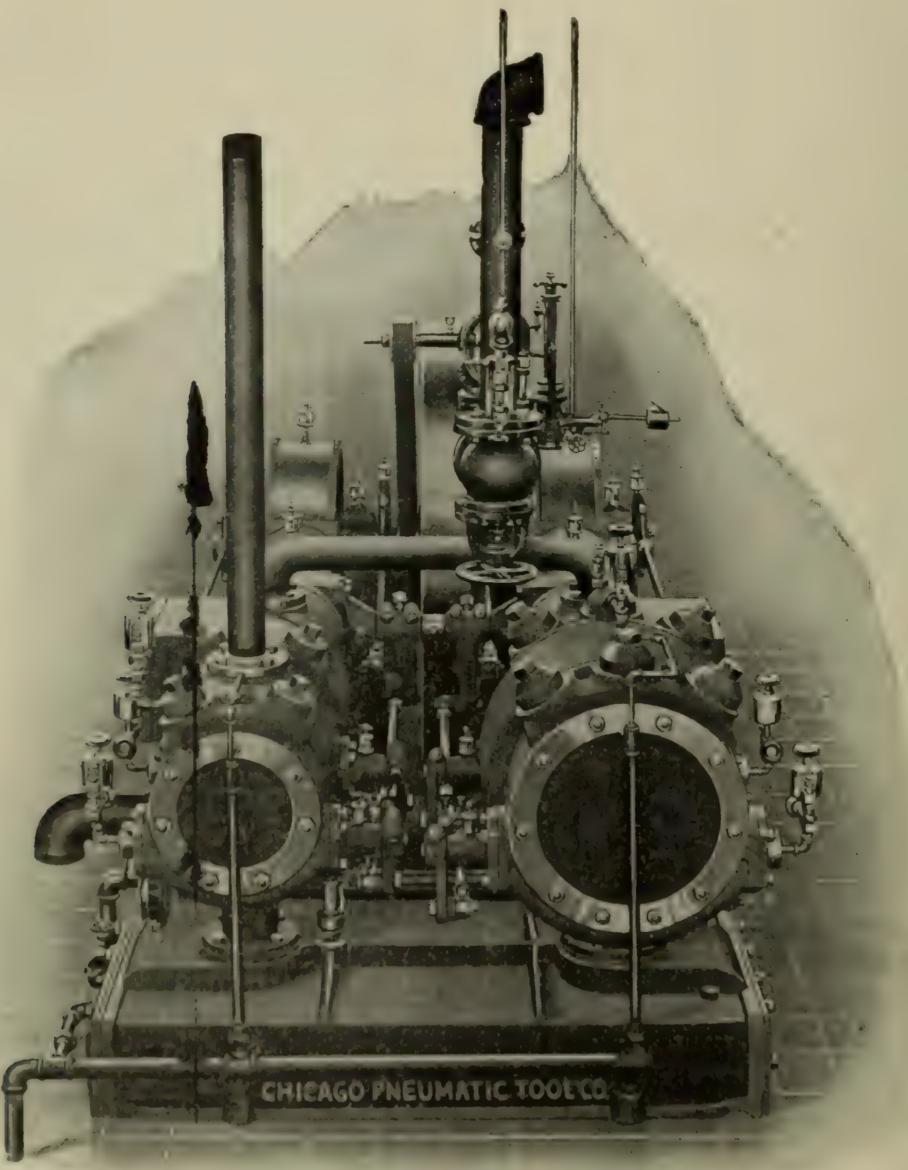
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The New Franklin Air Compressor.

THE Chicago Pneumatic Tool Company was among the first to produce a perfected line of pneumatic tools and appliances, and being manufacturers of machines using compressed air as a motive power, their attention was naturally attracted to the most efficient means of producing compressed air. These investigations eventually led to their entry into the field of compressor manufacture, enabling the company to offer complete equipment of its own make. Despite the fact that there are more than 2,000 Franklin compressors and 60 to 70 compressors per month are now being turned out, many are not aware that for the past five years the Chicago Pneumatic Tool Company has owned and operated its own plant at Franklin, Pa., for the manufacture of these compressors. Although designed primarily for the operation of pneumatic tools, these compressors have found a wide demand throughout all compressed air uses, more than taxing the output of a large plant, the productive capacity of which has been repeatedly extended. So busy have they been in keeping pace with their market, that barring an occasional trade item, little has appeared in the technical press concerning the remarkable development of this industry, and the accompanying illustration and description of a Franklin Air Compressor is one of the first published.

This machine in general follows the most advanced practice, being the result of experience gathered from the most successful compressor builders, avoiding weak spots and following original lines on points vital to maximum efficiency. The compressor shown herewith is especially suited to the requirements of industrial works, mines, quarries, etc. It is of duplex pattern, with simple or cross compound steam cylinders and simple or two-stage air compressing cylinders, according to working conditions. A variety of combinations is obtainable for varying pressure conditions, and machines are also built for motor or water wheel drive, either direct or by belt, gear or chain. These compressors are built in sizes ranging in capacity from 30 to 2,000 cubic feet of free air per minute displacement for 10 to 125 pounds per square inch working air pressure and suited to all compressed air users. Frames are heavy box shaped castings, graceful in outline, strongly ribbed with large factor of safety to withstand strain when working at maximum load. The bottom surface bearing upon foundations throughout its entire length insures stiffness not only at the main bearing, but also along the guides at the connection with the cylinder. This construction affords an even distribution of strain upon the foundation and also of the internal stresses which the bed itself must sustain. Cross head guides are bored and provision is made for catching and draining drip from bearings and stuffing boxes. Being entirely self-contained expensive foundations are avoided and expert erection services unnecessary.

The cylinders are made from a mixture of special iron and selected scrap and are of sufficient strength and thickness to withstand the pressure for which they are designed after reboring. The steam cylinders have interior walls covered with asbestos or mineral wool and are neatly lagged with planished iron. The air cylinders and cylinder heads are completely water jacketed, providing a thorough circulation of water with equal cooling at all points. The pistons are of solid type with cast iron spring rings, accurately fitted. The box cross head is provided with taper shoes, turned to fit the cylinder guides. These shoes have screw adjustments affording a ready means of taking up the slight wear and of securing proper alignment. Oil guards at each end of the lower slide on the bed give continuous lubrication to the lower shoe, while a sight feed oil cup on top of the bed provides the necessary oil for the upper shoe. The piston rod is screwed into the cross head and secured by a lock nut. The connecting rod is of substantial pattern with solid cross head and having wedge and adjustment screws. The crank end is of marine type, with heavy bolts and brass liners. The single compressor has two balance wheels, one on each side to insure smooth operation. Duplex and cross compound compressors have heavy fly wheels made in two sections, securely bolted to-



END VIEW TYPE OF G D S C AIR COMPRESSOR. ILLUSTRATES MECHANICALLY MOVED INTAKE VALVES.

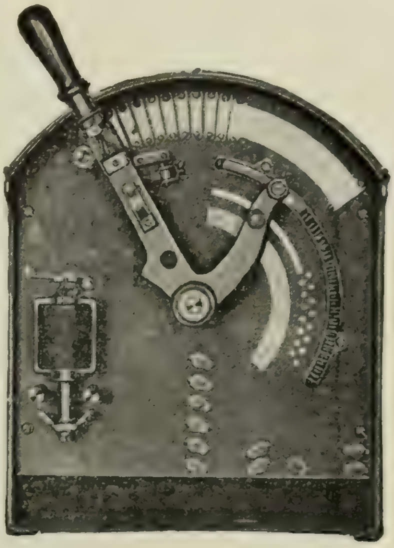
gether at the hub and at the rim. All bearings are of unusually liberal proportions and only the best materials are used in their construction, with the most improved provisions for adjustment, to eliminate all trouble from heating and to reduce wear in working parts to a minimum.

Steam driven compressors are provided with a pressure regulating governor to automatically control the operation of the compressor in accordance with the demand for air, working in connection with a speed governor which regulates the speed of the compressor. Single steam and belt driven compressors also have an unloading device to relieve the compressor of all load when the desired air pressure is obtained, and automatically cause it to resume delivery when the receiver pressure becomes reduced. Smaller steam driven compressors have plain "D" slide valves accurately scraped to seat and securely fastened to rod with adjustment for wear. Steam cylinders twelve inches in diameter or larger are provided with the Meyer adjustable cut-off valves, the main valve being balanced, thus reducing the liability of excessive wear and increasing the life of the valve and valve gear by relieving the strain upon all valve gear parts.

Franklin air compressors are especially designed for operating pneumatic chipping, caulking, riveting and stone cutting hammers, drills, reamers, sand rammers, wood boring machines, flue cutters, painting machines, straight lift and motor hoists, stone surfacing machines and all classes of compressed air equipment in machine shops, boiler shops, railroad shops, ship yards, stone yards and in bridge and building construction work; pumping natural or artificial gas, driving rock drills, coal cutters, pumps, locomotives, hoisting engines and other machinery in mines, tunnels and quarries; operating railway signals, testing and charging air brake equipments, sinking bridge caissons, displacing and agitating chemicals, pumping water by compressed air and for every other purpose for which compressed air is employed. Full information may be obtained from the manufacturers, the Chicago Pneumatic Tool Company, at its offices Chicago or New York, or any of its branches.

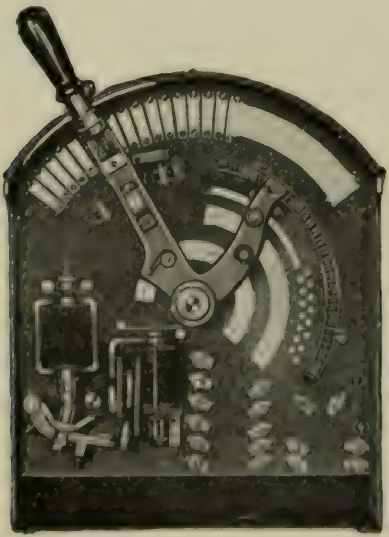
New Controller.

THE Cutler-Hammer Mfg. Co. of Milwaukee has recently placed on the market a new line of printing press and machine tool controllers. These controllers are of the well-known "Carpenter" type and embody the distinctive features of this class of Cutler-Hammer apparatus. The essential difference between the new controllers and the older type is that the former provide for a greater number of field speeds than the latter. At the time the first "Carpenter" printing press and machine tool controllers were placed on the market it was the accepted practice to obtain the major portion of speed variation by means of armature resistance, the increase in speed secured by means of field control, seldom exceeding 15 per cent. Of late, however, variable speed motors, so designed as to permit of their speed being increased as much as 400 per cent. by field control have come into use and the present line of controllers has been designed to meet this new condition in printing press and machine tool work.



CUTLER-HAMMER NON-REVERSIBLE COMPOUND CONTROLLER FOR PRINTING-PRESSES AND MACHINE TOOLS. UNDERLOAD RELEASE ONLY. COVER REMOVED.

Like the older type of apparatus the new line of controllers is provided with an auxiliary breaking device equipped with a powerful magnetic blow-out. In opening the circuit by moving the lever to the "off" position the break does not occur on the contacts, but on the auxiliary device located just below the contact segments. This prevents arcing on the contacts. The contact segments themselves are of hard-drawn copper and are separately renewable. The controllers are equipped with cast-iron covers which completely enclose all of the apparatus except the handle of the operating lever. The lever itself, instead of being cast in a straight bar, as in the older type of apparatus, is formed with a projecting arm carrying the contact shoe for the field speed points. This construction contributes to the compact arrangement of the controller. All contact parts are removable from the slate front without disturbing interior connection and all terminals are labeled with brass tags, insuring proper wiring. In this new line of controllers the speed regulation is effected by means of both armature and field resistance, the armature resistance being furnished separately, though it is possible to mount it with the front if desired. The field resistance is, in all cases, attached directly to the front of the controller and provision is made for holding the lever positively on any desired contact.



CUTLER-HAMMER REVERSIBLE COMPOUND CONTROLLER FOR PRINTING PRESSES AND MACHINE TOOLS, WITH UNDERLOAD, OVERLOAD AND PUSH-BUTTON RELEASE AND DYNAMIC BRAKE. COVER REMOVED.

Six distinct pieces of apparatus are comprised in this latest line of printing press and machine tool controllers—three non-reversible and three reversible. In each class the controller may be had with underload release only; with underload and overload release, and with underload, overload and push-button release and dynamic brake. The new apparatus is described in Cutler-Hammer's bulletins which will be sent on request.

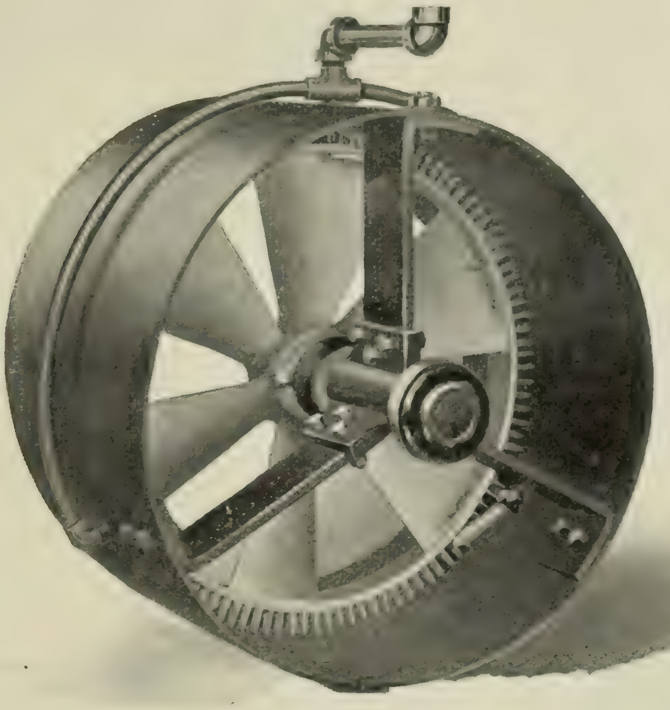
VIEW OF NEW CUTLER-HAMMER PRINTING-PRESS AND MACHINE TOOL CONTROLLER WITH COVER IN POSITION.

Double Crimped Wire Cloth.

THE Ludlow-Saylor Wire Co., St. Louis, are doubling the already large capacity of their plant for the manufacture of "Double Crimped" wire cloth, and especially for the style known by their trade name of "Perfect." Double crimping prevents the lodging of any rock splinters and the process is valuable for this reason, while the screening surface is fully twice as much as a perforated screen and the strain is more evenly distributed. Only the toughest wire is used, insuring long life, and this is especially true of the brass screens which are used wherever the water is acid. The mesh is accurate, giving, therefore, the best results.

Wing's Turbine Fan.

WING'S turbine fan is the combination of two machines, the Wing disc fan, and a well designed turbine engine. It is the invention of L. J. Wing, President of the L. J. Wing Mfg. Co., who originally invented and patented the disc fan, of which there are many thousands in use in this and other countries. The L. J. Wing Mfg. Co. have been putting them on the market over a year, and have met with great success, finding unlimited demand for such a combination. The blades of the fan are practically the same as those used on the Wing disc fan when used for ventilation, run by belt, electric motor, or direct connected old type engine. The turbine engine consists of a series of well designed turbine buckets or vanes fastened to a band or ring which in turn is fastened to the end or periphery of the fan blades, as shown on the illustration. Two or more nozzles of special design impinge the steam into the buckets, and causes the fan to rotate. This gives an economical and positive power. The small amount of steam from the nozzles after exerting all its energy in driving the fan passes right along with the air and, therefore, no exhaust pipe is required. This fan can be used in places where no other type of fan and engine could be used to advantage. At the present time they are used largely for mechanical draft for boilers. When used for this purpose the fans are masoned into the side or rear wall of the boiler just below the grates.

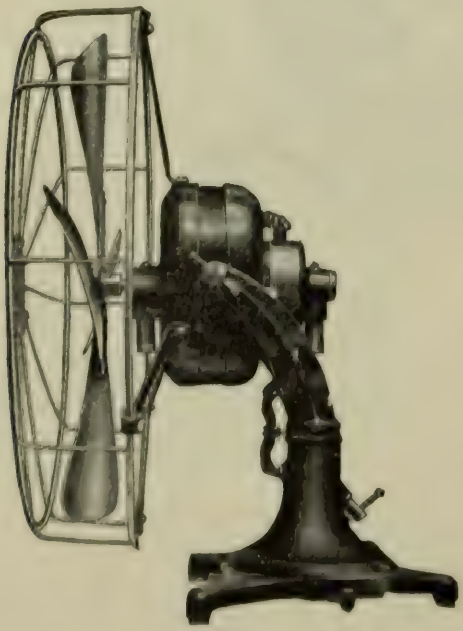


Mechanical draft enables the burning of a cheap grade of fuel which cannot be burned with natural draft. Aside from that there are other advantages, such as saving in cost of fuel, adding to capacity of boilers by heating the tubes more evenly and full length, thus keeping the boilers in better condition, and that the steam from the fan helps to deteriorate the clinkers, and keeps the grates in better condition. Another advantage is that this system of mechanical draft is flexible, while a chimney is not. The fans can be moved or more fans can be added as the plant grows, whereas the chimney cannot be moved or enlarged. The fans are not affected by atmospheric conditions as a chimney is.

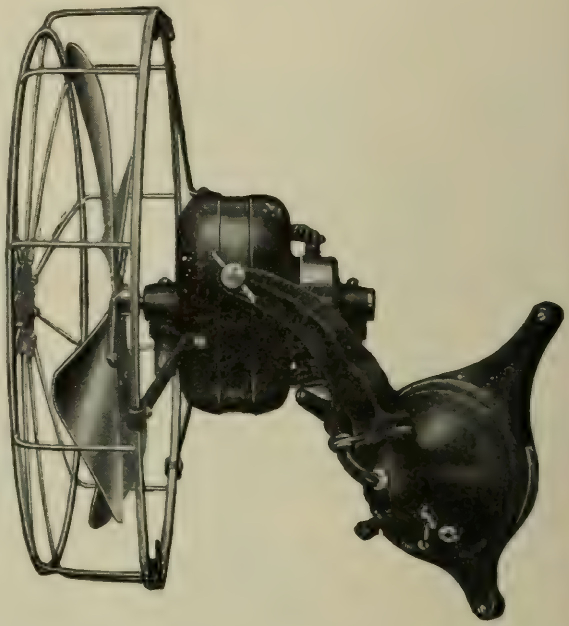
With a chimney draft it is necessary to clean the fire more often in order to keep up steam, whereas the chimney draft is constant, and is the same every day, and in case of sudden call for more steam, or bad coal the fans can be run at a higher speed, and the steam is kept up, while the chimney draft cannot be increased, and the steam drops and often make serious trouble and delays. The turbine fan being very simple and strong in its construction and having no wearing parts except the ball bearings requires no care or attention beyond putting some vaseline or other lubricant in the bearings once a month.

Alternating Current Fan Motor.

AN alternating current fan motor is now being placed on the market by the Western Electric Company which bids fair to be a great success. Heretofore the principal method of operating fans by alternating current has been by what is called the induction motor. The induction motor, however, has always had one great drawback and that is its uncertainty in starting immediately when the current is turned on. The reason for this trouble has been due to the simple fact that while most of the lighting and power companies furnish alternating current, it is nearly all what is known as single phase, and the ordinary induction fan motor will not run properly until it gets up to the proper speed. The starting torque is so small that it requires several spasmodic revolutions of the armature before the steady speed is obtained. The Western Electric's new fan motor does entirely away with this trouble by using a specially constructed commutator. They guarantee this motor positively to start when the current is turned on, because it does not operate on the induction principle, but in the same way as the regular series direct current fan motor.



Another great advantage of this motor is its "Universal" feature which allows it to be used either as a desk or bracket fan, and the change from one to the other can be made in a minute. They call it the "Two-in-One" type because it really makes one type of fan serve two purposes. An ingenious diagonal joint in the standard makes this change possible and a glance at the illustrations will make this clear. All the working parts of the motor are completely enclosed so that it is impossible to clog up the machinery with dust or dirt. From a mechanical standpoint the blades are great savers of current, the angles at which they are built following along specially designed lines, thereby furnishing maximum breeze with minimum current consumption.



Tests of Metal Windows.

ALL of the tests of fire retarding materials and devices that are referred to by those interested in the sale of such are conducted by the Underwriters' Laboratories (Inc.) at Chicago, where the National Board of Fire Underwriters maintains a most perfectly equipped plant for the practical and scientific determination of the value of structures submitted to them. For more than three years tests of metal windows have been held and cards of approval covering an extremely small percentage of those tested have been issued. Without this approval State underwriters may refuse to accept at minimum rating metal windows that are offered them. It devolves upon the architect therefore to insure his client against the purchase of material that will prove of doubtful value. All windows made of metal are fireproof in the sense that they will not add fuel to a fire, but, with a very few exceptions, they have been found of such faulty design, and in some cases inferior construction, that they failed utterly. The Laboratory test stimulates an actual fire continued for sixty minutes, readings of temperature that runs as high as 1,650°, and notes regarding the condition of the window being taken at intervals of five minutes. At the conclusion of the hour the front portion of the retort carrying the window, then a bright cherry red, is slid to one side and is played upon until cold by a standard fire hose stream at twenty feet distance. The window is afterwards cut up for examination and a record made of the method used in manufacture. All approved windows are inspected during process of manufacture and after completion by an engineer from the Laboratory and to all that meet with established standards for material, construction and workmanship is attached a brass tag, numbered and registered, as evidence of correct shop practice.

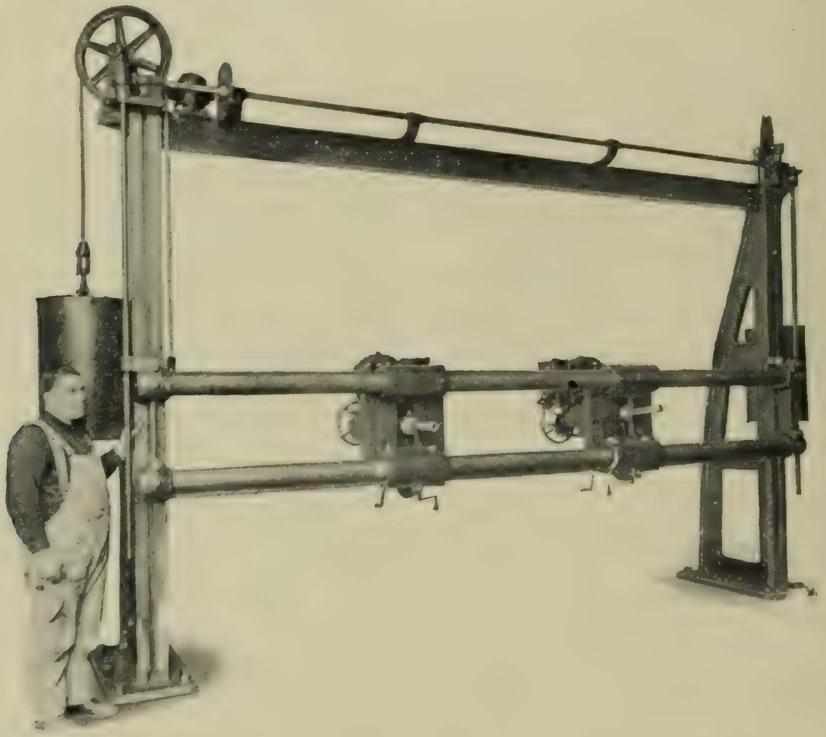
The windows made by Voigtmann & Company, Chicago, have been tested by the Laboratory and cards of approval issued by the National Board, and are made under direct supervision of the Laboratory's engineers. These windows are made in the only plant that is devoted exclusively to this one line, no cornices, skylights or other architectural sheet metal work being produced. Mechanics trained to produce one article must surely yield a result preferable to that possible if their effort is directed in various ways. Those interested in special or technical information concerning the manufacture and use of metal windows of stock design or special construction can secure, without charge, the services of a special department maintained by this firm.

Motor-Driven Boiler Shell Drill.

WE illustrate herewith a new boiler shell drill built by the Thos. H. Dallett Co., of Philadelphia, Pa. This machine is motor-driven throughout and has been designed for the special purpose of taking advantage of high speed steel, and as shown in the accompanying cut represents the latest development in machines of this character. As will be noted, there are two end housings, on the front face of which, carried by brackets, are two 5-inch bars on which are mounted two independent motor-driven drill-heads balanced by the counter-weights, having a vertical range of 6 feet and raised and lowered by means of screws actuated by a motor on the top rail of the machine, this motor being handled by a reversible regulator on the inside of the housing which does not appear in the cut. An especially noteworthy feature of this machine is the central position of the spindle, not only between the bearings of the drill-head on the bars, but also between the bars, so that the pressure of the drill against the work has no tendency to set up torsional or sidewise strains in the drill-head or bearings, causing excessive friction of the drill in the hole, rapid deterioration of the drill and undue consumption of power, owing to the spindle being thrown out of alignment, as must be the case where a drill spindle is not central of its supports. The machine is entirely self-contained, all adjustments being effected by means of crank handles and hand wheels, no wrenches whatever being required, and the operator has all the adjustments of the drill-head at his command from either side of the drill-head without moving from his position. In the lowest position of the carriage, the centre of the spindles are 21 inches from the floor, and in its highest position, 7 feet 6 inches. The distance between the housings is 14 feet and the distance between spindle centers when the drill-heads are in their outermost position is 12 feet. The length of the standard machine over all is 17 feet 8 inches, the height 11 feet 6 inches and the total weight 12,000 lbs.

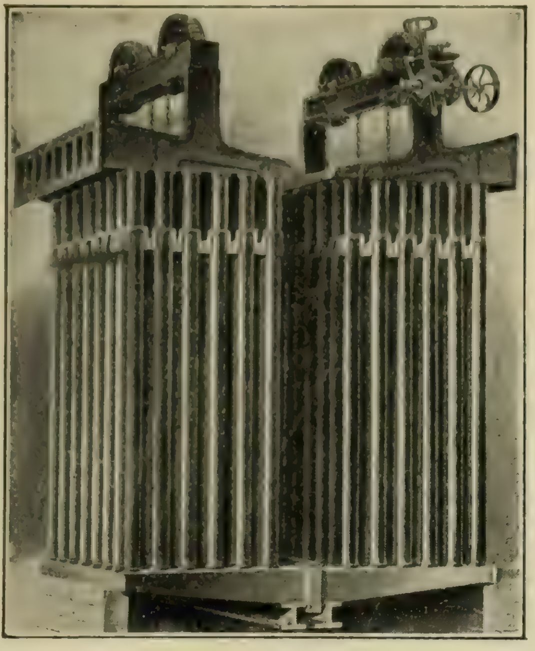
As this cut shows, each drill-head has a vertical adjustment in itself of 6 inches, operated by a crank handle at the bottom, and is moved along the bars by means of a pinion and rack on the under side of the lower bar. The motors shown on these drill-heads are Northern 2-H.P. variable speed motors, the regulating box and switch being mounted on the opposite side of the motor. There are no bevel gears used in the transmission from the motor shaft to the spindle, making a very durable and efficient gear reduction. The spindle speeds range from 80 r. p. m. to 160 r. p. m. and the whole mechanism of the drill-head is especially designed and built for the purpose of using high speed steel drills if desired. The spindle is 1-13/16 inches in diameter, is bored for a No. 4 Morse taper, has a traverse of 18 inches and a perpendicular range through an arc of 15° to permit drilling rivet holes radially to the center of the boiler, which is set on rollers in front of the machine. The last movement is controlled by the hand-wheel which appears immediately beneath the gear reduction.

The feeding mechanism consists of a feed-shaft, crank head, rocker pawl plate, pawl, ratchet wheel, feed nut and feed screw, the thrust of the latter being directly upon the back end of the spindle. The connecting rod between the crank and rocker plate is fitted with a spring which can be set for any pressure of feed, so that it is impossible for this pressure to be exceeded, as the spring is compressed when the limit is reached and the feed ceases to operate until the pressure is reduced, thus making an automatic relief. Change of feed is effected by shifting the thumb-latch around the crank head and a range of feeds from .005 inch per revolution of spindle to 1/16 inch can be obtained. This range of feed covers the entire requirements of drilling in boiler work.



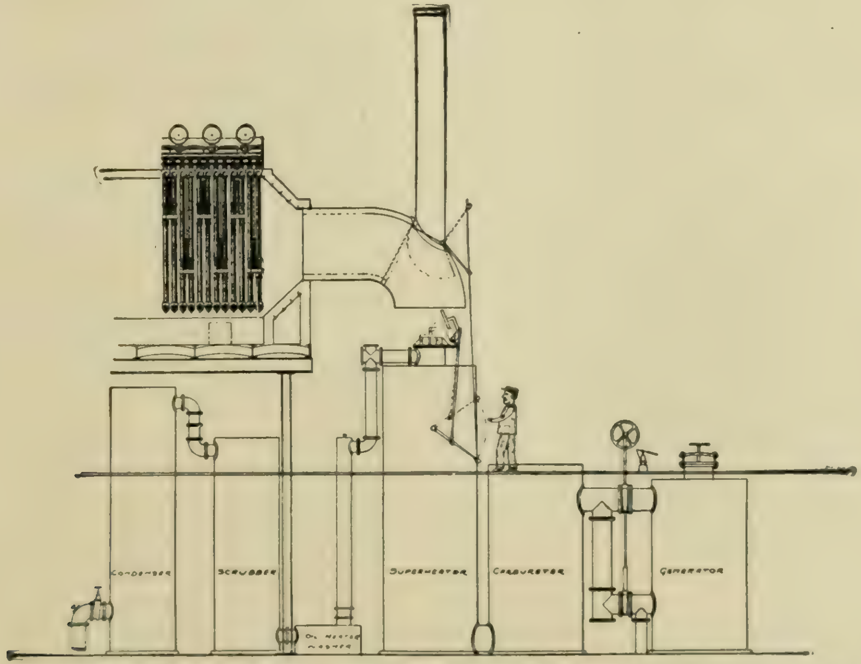
Saving Coal in Making Water Gas.

So much heat is carried away in the blow-up gases in making water gas that about 40 to 48 lbs. of anthracite or coke are required for the generator per thousand cubic feet of gas produced. Yet, only about half the B. T. U. contained in the coal are available in the gas; that is, the efficiency of the process is usually less than 50 per cent. We illustrate an arrangement adapted by the Newburgh Gas Light Company, of Newburgh, N. Y., which saves one-half of the waste and thus requires one-quarter less coal than the ordinary process. The plant consists of a generator 6′ x 14′, a carbureter in which the oil is added, of the same size, and a superheater 6′ x 22′. Formerly, after the blow-up gases from the generator passed



GREEN AIR HEATER OF 96 TUBES BEFORE ENCLOSURE.

through the carbureter and superheater, they were allowed to waste to atmosphere.



HOW THE GREEN AIR HEATER OR THE GREEN FUEL ECONOMIZER, OR BOTH, ARE USED TO RECOVER WASTE HEAT FROM THE STACK-VALVE GASES.

The saving has been accomplished by the recent addition of a Green air heater encased in a brick chamber above the charging floor and provided on one side with a sheet iron funnel which opens over the superheater escape valve. In this funnel there is an opening to a short stack with a damper, so that upon occasions, as when the air heater is being cleaned, the blow-up gases can be allowed to escape directly to the atmosphere as formerly. When this damper is closed, however, the gases pass into the chamber among the tubes of the heater and then to a stack on the farther side of the heater, through which they escape to the atmosphere. This stack also has a damper to control the draft. As the gases escape from the superheater into the hood they ignite, the carbon monoxide (CO) burning to carbon dioxide (CO_2) and liberating about 1,000 B. T. U. per pound of carbon monoxide thus burnt. By regulating the damper in the air heater stack the amount of air drawn into the hood with the gas may be so closely regulated that there is perfect combustion without the admission of excess cold air.

The Green air heater consists of a group of vertical cast iron tubes forced by hydraulic pressure into top and bottom boxes to form 4 or 8 tube units as shown in the accompanying photograph of an 86-tube heater. After it is set up the blow-up gases from the hood pass in among the tubes, while at the same time the air supply for the generator is forced through the tubes by a blower and takes up heat from the gases returning it to the generator. The result is that it is not necessary to blow the generator so long to bring it up to the required temperature and not so much fuel is required in the blowing-up process, with a resulting saving in the present case of about one-fifth of the fuel required for the generators. The outsides of the tubes are kept clean of soot by automatic scrapers which travel slowly up and down. The heater at Newburgh was installed in November, 1905, and a careful record kept of the cost. The results show a saving not only of coal, but also of the oil used in the carbureter, due probably to the higher average temperature at which the apparatus was operating. The stack valve gases which originally left at from 1,500 to 1,800° F., now leave at about 800° F., all the difference being absorbed in useful work. The Green Fuel Economizer Company of Matteawan, N. Y., have just issued a booklet containing complete tests and figures on the making of water gas and will send it free to anyone who writes.

NEWS SUPPLEMENT

The Engineering Magazine—June, 1907

Personal.

—A. Samuel Berquist, manufacturer of Berquist's suspension bunkers, will visit Europe on a business and pleasure trip in June.

—Charles H. Glasser, formerly mechanical engineer of the Camel Co., Chicago, has accepted a position with the American Steam Gauge & Valve Mfg. Co., and will make his headquarters at their Chicago office.

—E. P. Leadbetter has been appointed manager of the Pittsburg office of the Buffalo Forge Co. For the past three years Mr. Leadbetter has been connected with the Philadelphia office of the Buffalo Forge Co. and previous to that time at their factory office in Buffalo.

—Dr. F. P. Van Denbergh, for the past year chief chemist to the Belen Mines, Sonora, has recovered his health while in Mexico and returned to the United States and will settle at Santa Rosa, Leonard Wood County, New Mexico, to develop personal interests in New Mexico.

—The Under-Feed Stoker Co. of America, manufacturers of the Jones stoker, Marquette Building, Chicago, announces the appointment of Paul M. Chamberlain, M. E., as chief engineer. Mr. Chamberlain was graduated in engineering at the Michigan Agricultural College in 1888 and at Cornell University in 1890. After several years spent in practical work with the Brown Hoisting & Conveying Machinery Company of Cleveland; Frick Company, engineers, of Waynesboro, Pa., and the Hercules Iron Works of Aurora, Ill., he accepted the assistant professorship of mechanical engineering at the Michigan Agricultural College.

Industrial Notes.

—American Gas Furnace Co. are now located at 24 John St., New York.

—Robb-Mumford Boiler Co. have moved their New York offices to the West Street Building, 90 West St.

—The Chicago office of the Norton Company and the Norton Grinding Co. is now located at 48 So. Canal St.

—Albany Steam Trap Co., manufacturers of steam traps, announce that they have removed their plant to No. Pearl Street, Albany.

—Northampton Portland Cement Co. announce that their sales office is now located at the general office and mill, Stockertown, Pa.

—Hudson Engineering & Contracting Co. announce that they have moved their offices to the West Street Building, 90 West St., New York.

—The Mississippi Glass Co. has purchased the Sergeant Glass Co.'s plant at Kane, Pa., and will operate it in manufacturing rolled, figured, polished plate and fire glass.

—Pittsburg Foundrymen's Association are to be guests of The S. Obermayer Co. in June. A special train will take them on a tour of inspection to The S. Obermayer Co.'s new plant at Rillton, Pa.

—The Norton Grinding Co., Worcester, manufacturers of cylindrical grinding machinery, bench and floor grinding machinery, are erecting a building which will double their present capacity.

—Sturtevant dry kiln apparatus is being installed in connection with lumber dry kilns for Theodore Kuntz, Cleveland, Ohio; E. S. Adkins & Co., Salisbury, Md.; and Bennett Lumber & Mfg. Co., Bennett Station, Pa.

—A. D. Granger Co. announce the change in its New York office to the West Street Building, 90 West Street, where they have much larger and more commodious offices arranged for the better conduct of their business.

—The New York office of the B. F. Sturtevant Company has just been removed from 131 Liberty Street to the Engineering Building at 114 Liberty Street, where much better facilities will be provided for conducting the increasing business of this company.

—The American Locomotive Co., Schenectady, N. Y., is installing an electrically-driven Sturtevant fan to remove smoke from the new running shed. This is practically a duplicate of one previously furnished by the B. F. Sturtevant Co., Boston.

—The Western Electric Co., Chicago, are about to issue their 1907 edition of their supply catalogue. This will be a large volume of 700 pages, and will list everything of any importance in the electrical line. The edition for this year will be much more complete and instructive, however, than any which has heretofore been published by this company.

—The Epping-Carpenter Co., manufacturers of pumping machinery, Pittsburgh, Pa., have made a change in their New York representation, Chas. T. Henry Company, of 141 Broadway, being no longer their agent, they (Epping-Carpenter Co.) having opened an office at 90 West Street, in the new West Street Building; the office is in charge of Messrs. F. B. Slocum and George B. Ferrier, Jr.

—Among recent sales of generating sets made by the B. F. Sturtevant Co., Boston, are the following: Isador Fajans, New York; Augusta Lumber Co., Augusta, Me.; Norfolk & Washington Steamboat Co., Newport News, Va.; North Packing & Provision Co., Somerville, Mass.; Fisheries Co., Philadelphia, Pa.; Lincoln Mfg. Co., Fall River; and Hudson Companies, New York.

—The Norton Company, Worcester and Niagara Falls, manufacturers of grinding wheels made of alundum and other abrasive specialties, is to erect a large addition to its Worcester works. They will extend the building designated as Plant 2 about 200 ft. in length by 111 ft. in width, which will more than double the present capacity. This will be fully equipped with kilns, mixing machines, shaving machines, etc., so as to permit of a large increase in output.

—J. H. Wagenhorst & Co., Youngstown, O., manufacturers of the Wagenhorst electric blue printing machines, announce a partial list of recent sales as follows: S. M. Greene, Holyoke, Mass.; Monongahela River Cons. Coal & Coke Co., Pittsburgh; George S. Mills, Toledo, O.; Eugene Dietzgen Co., New York; Babcock & Wilcox, Barberton, O.; J. W. Gaddis, Vincennes, Ind.; Multi-Color Copying Co., Detroit; American Steel & Wire Co., Joliet, Ill.; Thomson Stationery Co., Vancouver B. C.

—The largest order for steel rails ever placed with a single concern was made public May 11. This was the order for 150,000 tons of steel rails placed by the Harriman lines with the Tennessee Coal and Iron Co. for delivery after March, 1908. In order to handle its greatly increased business the Tennessee Coal & Iron Co. has just placed an order with the Crocker-Wheeler Co., Ampere, N. J., for the complete electric motor equipment of its new steel rail mill at Birmingham, Ala.

—Among the many sales closed last month by the Under-Feed Stoker Co. of America, Marquette Building, Chicago, occurs an order for the installation of twenty stokers in two separate plants of the Dixie Portland Cement Co., Copenhagen, Tenn., each plant consisting of 5 400 H.P. Heine boilers. The Georgia Railway & Electric Company also has placed an order for Jones stoker equipment. When installed this will make a total of thirty-six Jones stokers in their Butler St. Station, equipping 7,200 H.P. of B. & W. boilers.

—The Abner Doble Co., engineers of San Francisco, have appointed Mitsui & Co. to act as their sole agents in Japan and its territories, Korea, China and Manchuria, for the sale of Doble tangential water wheels and hydraulic apparatus. The industrial development that is now taking place in the Orient, and the increasing demand for high grade water wheel machinery will make this co-operative arrangement an advantageous one for both parties. Mitsui & Co. is one of the largest and most progressive engineering houses in the Far East.

—The Trustees of the Rensselaer Polytechnic Institute have decided to establish courses in mechanical and electrical engineering. The recent gift of one million dollars from Mrs. Sage and other recent gifts through which they have been able to increase the value of their plant for the purposes of instruction, enables them to do this. These courses will be very general engineering courses. In this respect they will be similar to the civil engineering courses now given at the Institute which has always been very general in its character.

—The Lunkenheimer Co., Cincinnati, has established its Eastern office and warehouse in much more commodious quarters, in the building at 66-68 Fulton Street, New York, recently erected; Alfred J. Jupp managing this division of the company's business. In making provision for an adequate stock from which to supply the Eastern and Atlantic Coast trade easily and quickly, it was necessary to use to the best advantage the space occupied, and by somewhat unique methods prepare for the accommodation of a large assortment as well as sufficient quantities, so arranging the irregular floor space as to have it attractive in appearance.

—The dynamo-dynamometers for testing automobile engines, which have been supplied by Joseph Tracy to a number of the leading automobile builders, will in future be marketed by the Sprague Electric Co. under an arrangement by which Mr. Tracy will supervise the construction of the apparatus, which will be manufactured at the Sprague Electric Company's works. The increasing use of this accurate means of determining the horse power of gasoline engines is in line with the growing movement toward standardization and correct power ratings. The method has been used for a number of years abroad by the Panhard concern and other notable builders, and is now being taken up quite extensively by American manufacturers.

—The Illinois Central R. R. Co. have just placed with Wm. B. Scaife & Sons Co., Pittsburgh, the eighth and ninth contracts for We-Fu-Go water softening and purifying systems, comprising a 300,000 gallon per day plant for Manchester, Iowa, and a 400,000 gallon per day plant for Waterloo, Iowa. Among some of the recent orders placed for We-Fu-Go and Scaife water softening and purifying systems are the American Steel & Wire Co., Donora, Pa., 12,500 H.P. We-Fu-Go system; American Sheet & Tin Plate Co., Cambridge, Ohio, 1,000 H.P. We-Fu-Go system; The Woodward Iron Co., Woodward, Ala,, a 10,800 H.P. We-Fu-Go system; for the Minneapolis, St. Paul & Sault Ste. Marie R. R. Co. a 250,000 gallon per day We-Fu-Go continuous system; for the Coshocton Straw Paper Co. a 500 H.P. Scaife system.

—Locke Regulator Co., Salem Mass., announce the following list of recent sales: Chas. Scribners' Sons Co., New York, 6 stops; Stearns & Foster Co., Lockland, Ohio, 1 stop; Ball & Wood Co., Elizabethport, N. J., 1 stop; Otsego Paper Co., Otsego, Mich., 1 stop; La Crosse Rubber Co., La Crosse, Wis., 1 stop; Fuller & Johnson Mfg. Co., Madison, Wis., 1 stop; Gisholt Machine Co., Madison, Wis., 3 stops; American Steel & Wire Co., Allentown, Pa., 1 stop; Minneapolis Steel & Machinery Co., Minneapolis, 1 stop; Chicago-Kenosha Hosiery Co., Kenosha, Wis., 1 stop; Vincennes Electric Light Dep't., Vincennes, Ind., 1 stop; Ryegate Paper Co., East Ryegate, Vt., 1 stop; Chattanooga Plow Co., Chattanooga, 1 stop; T. M. Sinclair & Co., Cedar Rapids, Mich., 1 stop; Morgan Engineering Co., Alliance, Ohio, 1 stop; Simmons Mfg. Co., Kenosha, Wis., 1 stop; International Paper Co., Fall

Mountain Mill, Bellows Falls, Vt., 2 stops; Colin Gardner Paper Co., Middletown, Ohio, 2 stops.

—The Heine Safety Boiler Co., St. Louis, reports some recent sales as follows: Asano Cement Co., Tokio, Japan, 4 boilers aggregating 900 H.P.; Atlantic, Gulf & Pacific Co., 4 200 H.P. boilers; American La France Fire Engine Co., Elmira, 2 230 H.P. boilers; American Locomotive Works, Richmond, 4 400 H.P. boilers; Bridgeport Forge Co., Bridgeport, 3 250 H.P. boilers; Crown Cotton Mills, Dalton, Ga., 2 400 H.P. boilers; Home Brewery, Columbus, 3 200 H.P. boilers; Hudson Companies 2 316 H.P. boilers; Independence Kansas Cement Co., Independence, Kas., 3 400 H.P. boilers; James S. Kirk & Co., Chicago, 2 500 H.P. boilers; Jos. J. Little Building, New York, 3 275 H.P. boilers; Quincy Horse R'y & Carrying Co., Quincy, Ill., 3 316 H.P. boilers; City of New York for Ridgewood Pumping Station, 8 300 H.P. boilers; Pueblo & Suburban Traction & Lighting Co., Pueblo, 1 378 H. P. boiler; Denver Gas & Electric Co., Denver, 3 524 H.P. boilers; Texas Co., Beaumont, 32 200 H.P. boilers for 8 pipe line oil pumping stations in Texas; Victor Talking Machine, Camden, 2 316 and 2 270 H.P. boilers; Warren Mfg. Co., Warren, R. I., 1 323 H.P. boiler, making a total of 2,881 H.P. on six orders; Willamette Pulp & Paper Co., Oregon City, Oregon, 1 250 H.P. and 2 366 H.P. boilers; U. S. Navy Department for Norfolk Navy Yard, 2 428 H.P. boilers and 4 350 H.P. boilers; U. S. Navy Department for Charlestown Navy Yard through Muralt & Co., New York, 4 350 H.P. boilers, and Philadelphia House of Refuge, Glen Mills, Pa., 4 250 H.P. boilers.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Sullivan Machinery Co., Chicago.—"Modern Practice in Air Compression" is the title of catalogue No. 58 treating of air compressors. Well printed and finely illustrated. 6 by 9 in.; pp. 112.

Air Compressor Outfits.

Abenaque Machine Works, Westminster Station, Vt.—Bulletin illustrating and describing gas and gasoline driven direct connected air compressor outfits. 6 by 9 in.; pp. 8.

Blocks.

Lane Bros. Co., Poughkeepsie, N. Y.—Catalogue containing an illustrated description of automatic tackle blocks, with prices and sizes. 6 by 9 in.; pp. 32.

Boilers.

Robb Engineering Co., Ltd., Amherst, N. S.., Canada.—Catalogue illustrating and describing Robb-Mumford boilers, tubular boilers, vertical boilers and marine boilers. 6 by 9 in.; pp. 50.

Lyon Brothers Co., Chicago.—Booklet containing a brief illustrated description of the Bonson boiler, which is a combination of the tubular and water tube types. 4 by 9 in.; pp. 16.

Buildings and Bridges.

Berlin Construction Co., Berlin, Conn.—Well printed catalogue illustrating and describing some of the recent buildings and bridges erected by this Company. 8 by 5½ in.; pp. 80.

Coal Handling Machinery.

C. W. Hunt Co., West New Brighton, N. Y. —Catalogue No. 072 illustrating and describing coal handling machinery for power stations, boiler rooms, coaling stations, etc. 6 by 9 in.; pp. 62.

Dies and Taps.

Wiley & Russell Mfg. Co., Greenfield, Mass. —Catalogue, pocket size, illustrating and describing screw cutting and other labor-saving machinery and tools. 3½ by 5½ in.; pp. 224.

Drawing Tables.

R. E. Kidder, Worcester.—Booklet containing an illustrated description of many different styles of drawing tables with prices and dimensions. 4½ by 7 in.; pp. 10.

Fans.

Garden City Fan Co., Chicago.—Catalogue No. 24 illustrates and describes fans, exhausters, blowers, etc., together with tables giving sizes, prices, etc. 9 by 6 in.; pp. 126.

Fan Motors.

Western Electric Co., Chicago.—Bulletin No. 4007 illustrating and describing the 1907 model fan motors, together with tables giving code word, list number, voltage, approximate amperage and list price. 6 by 9 in.; pp. 44.

Feed-Water Purifiers.

F. E. Keyes & Son, New York.—Leaflet illustrating and describing feed water purifiers. Also gives sizes and prices, together with a partial list of users. 4½ by 7½ in.; pp. 4. Also a pamphlet illustrating and describing the Advance boiler feed and purifier. 4½ by 7½ in.; pp. 4.

Feed-Water Haters and Purifiers.

Hoppes Mfg. Co., Springfield, O.—Catalogue illustrating and describing live steam feed-water purifiers, exhaust steam feed-water heaters and purifiers, steam separators, oil eliminators and exhaust heads. 6 by 9 in.; pp. 40.

Gas Engines.

Miller Improved Gas Engine Co., Springfield, O.—Catalogue illustrating and describing gas engines. Also contains a list giving sizes. 6 by 9 in.; pp. 12.

C. H. A. Dissenger & Bro., Wrightsville, Pa. Catalogue illustrating and describing stationary, portable and traction gas and gasoline engines. 10 by 7 in.; pp. 44.

Carlin Machinery & Supply Co., Allegheny. —Bulletin No. 16, illustrates and describes gas and gasoline engines. 6 by 9 in.; pp. 4. Bulletin No. 20 treats of gas driven air compressors. 6 by 9 in.: pp. 4.

Gas Producers.

Backus Water Motor Co., Newark.—Catalogue illustrating and describing suction gas producers and gas engines. 9 by 6 in.; pp. 16.

Gauges.

Ashcroft Manufacturing Co., New York.—Well printed catalogue illustrating and describing steam pressure and vacuum gauges, Edson recording gauge, Tabor steam engine indicator and a general line of engineering instruments, together with prices. Bound in cloth. 6 by 9 in.; pp. 136.

Graphite.

Joseph Dixon Crucible Co., Jersey City.—"A Study in Graphite" is the title of a booklet giving in detail a series of tests of graphite made by Prof. W. F. M. Goss of Purdue University. 6 by 9 in.; pp. 44.

Grinding Machines.

Roth Bros. & Co., Chicago.—Bulletin No. 156 illustrates and describes electric motor grinding and polishing machines. 6 by 9 in.; pp. 8.

Emery Wheels.

Springfield Mfg. Co., Bridgeport.—Catalogue illustrating and describing emery wheels and grinding machinery. 66½ by 9½ in.; pp. 102.

Jacks.

Joyce, Cridland Co., Dayton.—Leaflet illustrating and describing lifting jacks for stone yards and quarries. Also gives sizes, prices, etc. 4 by 9 in.; pp. 8. Also a folder descriptive of a new jack designed especially for railway use. 4 by 9 in.; pp. 8.

Japanning Ovens.

E. E. Steiner, Newark.—Leaflet illustrating and describing ovens particularly adapted for baking, drying, laquering, core drying, etc., together with a partial list of users. 4¼ by 7 in.; pp. 8.

Lubricators.

Greene, Tweed & Co., New York. Catalogue illustrating and describing the latest improved Rochester automatic lubricators and their mode of application to some of the many types of engines, pumps, machines, elevators, etc., to which they are adapted. 6 by 9 in.; pp. 72.

Mine Locomotives.

Jeffrey Mfg. Co., Columbus.—Bulletin No. 12 treats of the care of electric mine locomotives in service. The bulletin is well printed and contains many illustrations. 8 by 10 in.; pp. 80.

Pipe.

Abendroth & Root Mfg. Co., Newburgh, N. Y.—Handbook No. 39 contains a price list, with illustrations, of spiral riveted pipe, water tube boilers, hydraulic mining supplies, etc. 4½ by 7½ in.; pp. 128.

Pipe Threading Machines.

Toledo Pipe Threading Machine Co., Toledo. —Illustrated catalogue briefly describing pipe threading machines. 7 by 5 in.; pp. 20.

Propeller Fans.

B. F. Sturtevant Co., Boston.—Bulletin No. 146 illustrates and describes electric propeller fans. The fans are built in sizes ranging from 18 inches to 120 inches. 6½ by 9 in.; pp. 8.

Pumping Machinery.

United Iron Works, Oakland, Cal.—Folder No. 25 treats of pumps for irrigation, reclamation and general pumping service. 6 by 9 in.; pp. 12. Folder No. 27 is devoted to an illustrated description of automatic excavators. 6 by 9 in.; pp. 12.

Rails.

William Wharton, Jr., & Co., Philadelphia. —Cloth bound catalogue, fully indexed, illustrating and describing rails and special track work. 11 by 8½ in.; pp. 180.

Regulators.

Locke Regulator Co., Salem, Mass.—Booklet containing an illustrated description of pressure regulators. Valves, tumbling barrels, engine-stops and safety devices are also treated. 6½ by 3¼ in.; pp. 24.

Reinforced Concrete Construction.

L. J. Mensch, Chicago.—Illustrated pamphlet showing some buildlings recently constructed of reinforced concrete. 9 by 12 in.; pp. 32.

Aberthaw Construction Co., Boston.—Catalogue describing reinforced concrete as used in manufacturing plants. Illustrated with many views showing buildings, dams, etc., constructed by this Company. 6 by 9 in.; pp. 32.

Rock Drill.

Ingersoll-Rand Co., New York.—Booklet 20A illustrates and describes the new Temple-Ingersoll electric-air rock drill. 5½ by 3¼ in.; pp. 18.

Separators.

Potter Separator Co., Newburgh, N. Y.—Catalogue illustrating and describing mesh separators and superheaters. Also contains numerous testimonial letters and a partial list of users. 6 by 9 in.; pp. 16.

Steam Pumps.

Emerson Steam Pump Co., Alexandria, Va.—Pamphlet containing testimonial letters from recent users of their steam pumps, quick cleaning strainers and foot valves. 6 by 9 in.; pp. 16.

Valves.

Crane Co., Chicago.—Booklet illustrating and describing valves, fittings and appliances for

No. 4 pages 35-93

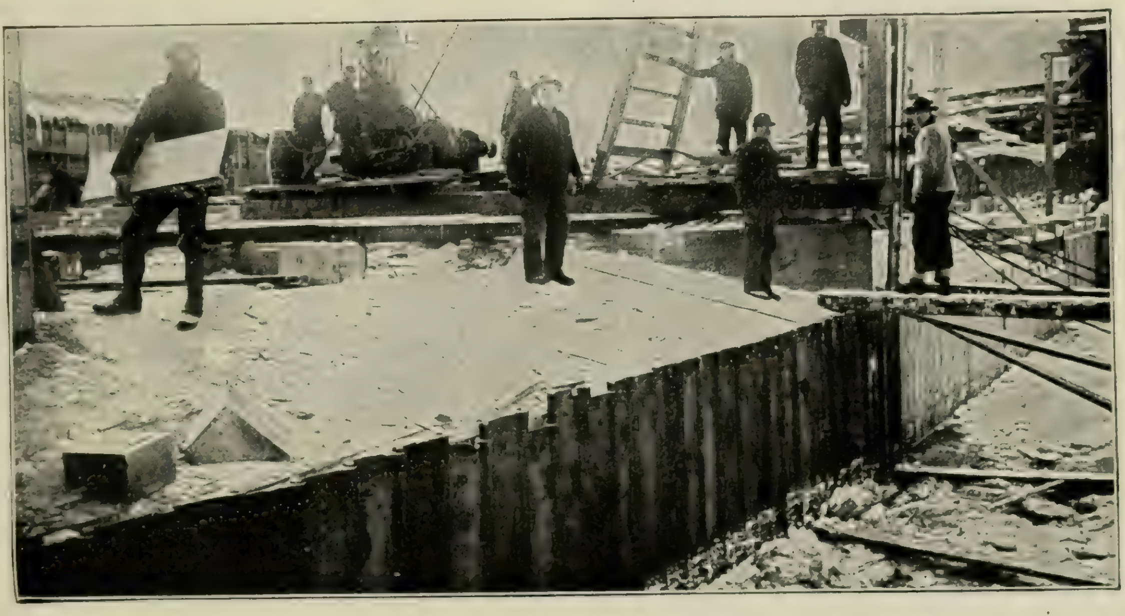
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Sheet Steel Piling.

THE Watab Pulp and Paper Company and the Watab Rapids Power Company have recently completed a huge power plant, together with what is considered to be one of the most complete pulp and paper mills in the world, on the Mississippi river at Sartell, Minn. The plant is driven entirely by hydraulic power developed by a dam across the river at the site. The construction of the buildings, forebay, canal, flumes, tail-race, etc., involved no unusual difficulties, but the construction of the main dam was a hazardous undertaking. This dam is a rock-filled timber-crib structure with reinforced concrete abutments at each end. The original bed of the river, which was 600 ft. wide at the site before construction was started, consists of a hard clay soil with a layer of gravel, and in the river at the site of the dam there was a series of rapids over which the water flowed with considerable force even during low stages in the river; while during the flood periods the current was exceedingly swift and violent. At this site also the river has a maximum depth of 30 ft. during normal stages, which added greatly to the difficulties of the construction of the dam. A section of the dam was first built in the water over the desired location and was lowered with rock to sink and anchor it, heavy steel cables being used to prevent it from drifting away. This section was built from the opposite shore to midstream and of a height which permitted the water to flow over it until the construction of that part of the dam adjoining the power house was well under way; but at the midstream end the height was about seven feet above water level, so as to provide for a suitable connection with a cofferdam necessary to be used in the construction of the power house section, which embraced the flood gates and log sluice.



Various methods were considered for controlling the waters to facilitate the construction of the power house section of the dam, but only two were deemed feasible for the accomplishment of satisfactory results. One method contemplated the building of cofferdams of rock and puddle filled timber cribs; the other involved the use of steel sheet piling. On account of adverse results in the prior use of interlocking steel piling in the vicinity of Sartell, as well as of the fear that the steel piling could not be driven into the hard clay soil and gravel, or, if so driven it was certain to be practically impossible to withdraw, it was concluded to employ the timber-crib construction; and accordingly two timber-cribs were built for cofferdams intended to lay bare about half the width of the river bed next to the power house. One of these cribs was built on the up-stream side and the other on the down-stream side of the crib of the main dam connecting with the latter at the stream end and with the river bank at the other end. The crib on the up-stream side was rock-filled and was built parallel with the crib of the main dam 50 ft. from the latter, and joined the main dam 200 ft. off shore. This crib was protected from the rapid current of the river by an additional rock filled timber crib built 25 ft. up stream from it in order to make possible a water-tight construction, this crib acting as a break-water. The crib on the down-stream side was earth-filled, and was also built parallel with the crib of the main dam and 50 ft. from it, so that these up-stream and down-stream cribs formed a cofferdam 150 ft. wide and 200 ft. long. The down-stream crib did not require to be carried to as great a height as the one on the up-stream side, owing to the difference in the water levels above and below the crib of the main dam. During construction the stream was gradually diverted around the end of the cofferdam described and over that part of the crib for the main dam which was not enclosed by the cofferdam, thus raising the head against the cofferdam and greatly increasing the current. After the up-stream crib of the cofferdam had been completed it was pushed somewhat out of line by the current and rendered useless as a water-tight structure. This necessitated the building of another rock and puddle filled timber crib within the space enclosed by the first one, but all attempts to seal even this auxiliary cofferdam with clay and puddle were unsuccessful, the current being so strong as to carry away the materials as fast as they could be placed and undermining both cribs. It was then concluded to employ United States steel sheet piling to seal the up-stream cribs of the cofferdam. The piling was driven between the two cribs on the out-stream side, as there was a distance of seven feet between them at this place, because the rock from the outer crib having lodged there when it failed, and through some of which the piling had to be driven in order to have a footing in the river bed to insure water-tightness. On the up-stream side, however, the piling was driven at the up-stream side of the outer crib, getting the full benefit of the swift current. The water was 25 to 30 ft. deep for a width of 140 ft. at the end of the cofferdam on the shore side, and across this deep place 30 ft. lengths of piling were first driven and followed by driving on top of them 10 ft. lengths in order to secure sufficient penetration in the clay bottom of the river to insure against any possibility of undermining. The alternate piles along the side of the cofferdam were driven 18 in. to 2 ft. deeper to break joints in that manner between the 30 ft. and 10 ft. lengths. After more shallow water was reached 30 ft. lengths only were used and were driven to a penetration of from 15 to 20 ft. The steel piling was driven at the rate of about 30 piles per day with a 10-h.p. hoisting engine and an ordinary drop hammer in connection with the usual pile driver for the driving of wooden piling.

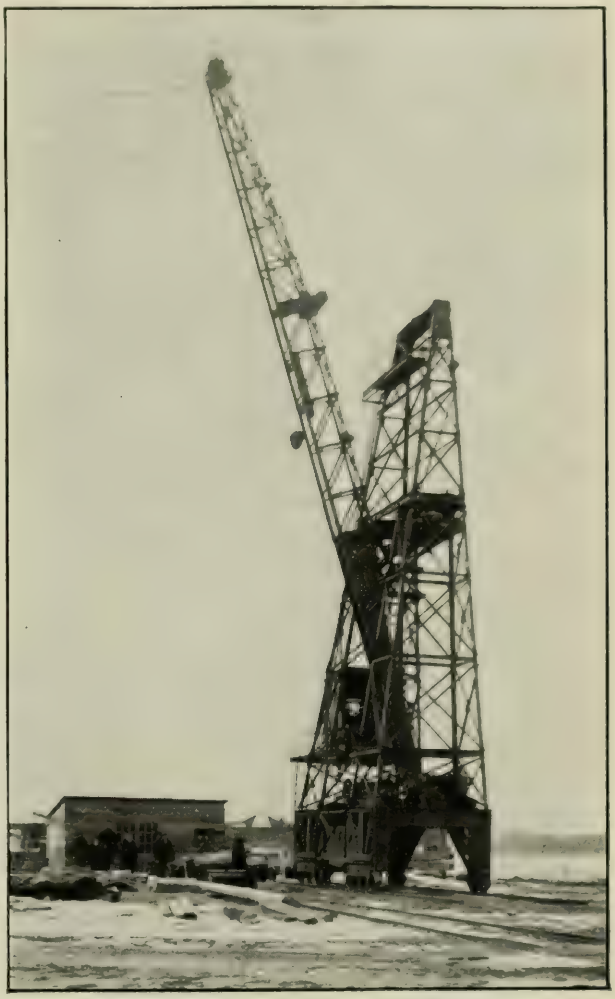
After the steel piles had been driven the seepage was cut off entirely and there was no further trouble from undermining. A considerable quantity of water, however, came through the crib of the main dam, but the water level in the cofferdam was kept down by using one 8 in. and three 10 in. centrifugal pumps. While the water level was lowered the crib of the main dam and the sluice ways and log sluice were constructed and the steel piling afterwards withdrawn. The steel piling had produced such immediate results that it was decided to face the main dam for its entire length with steel piling, for the purpose of cutting off all seepage and thus insure the stability of the entire structure, as well to maintain the maximum efficiency of the dam. Steel piling was also driven in front of a concrete break-water built to protect the bluff of the river, for 100 ft. down stream. This piling was for the purpose of preventing the undermining of the break-water by the scour or tow created by the rapid water in the tail race, and likewise insuring the foundation of the mill building.

The work of pulling the piles in the cofferdam was done in February under as unfavorable conditions as could be imagined. The temperature was as much as 45° below zero Fahrenheit when the work of pulling was commenced. The puddle rock and clay on the bank through which the piles were driven, and the water in the river had been exposed from the inside of the cofferdam and were frozen to a depth of 10 to 12 ft. As the whole cofferdam, the river bank and the crib of the main dam were frozen, the use of dynamite to loosen the piles might have injured the mill building. A steam jet was therefore arranged to thaw the earth around the piles before pulling them. A pipe line was laid from the boiler house to the point of operations and supplied live steam to this jet. Two 18 in. triple blocks with a wire cable in connection with the equipment for driving were used and the pulling of piling progressed at the rate of 18 to 20 pieces each day.

Cranes for Panama.

THE accompanying illustration shows one of a lot of eight cranes now under construction by Shaw Electric Crane Co. of Muskegon, Mich., for the Panama Railroad Co. They are for use in handling miscellaneous freight at the Laboca wharf, which is the Pacific terminus of the railroad. The cranes were designed to meet the peculiar conditions existing at the wharf, among which is a tidal variation of about 20 feet. The boom, which is 80 feet in length, is shown in one view in its working position, standing at an angle a little over 30° from horizontal. It is required that the outer end should stand at sufficient height to carry loads over the decks of the largest vessels at high tide, while the other end must be low enough to project inside of the warehouse door. The boom may be raised to the position shown in the other view, carrying the outer end clear of all parts of vessels and withdrawing the inner end from the warehouse. With it in this position, vessels may be docked and the cranes placed opposite the various hatchways in proper position for loading or discharging cargoes.

The main frame or tower is of steel construction, and stands 62 feet above the track. There is a clear opening through it 10 feet wide, in which the boom is suspended and through which the loads are carried. The base is so constructed that the crane can travel over freight piled to a height of 6 feet between the tracks, and so that goods may be trucked directly from under the crane to the warehouse. The space between the front of the warehouse and the edge of the wharf was sufficient for a track of only 11 feet gauge. This, together with the necessary height and reach, made the question of stability a serious one. Although the weight of frame and machinery has been so disposed that the crane will be stable with a load 25 per cent. above normal capacity in the extreme position, clamps have been provided which



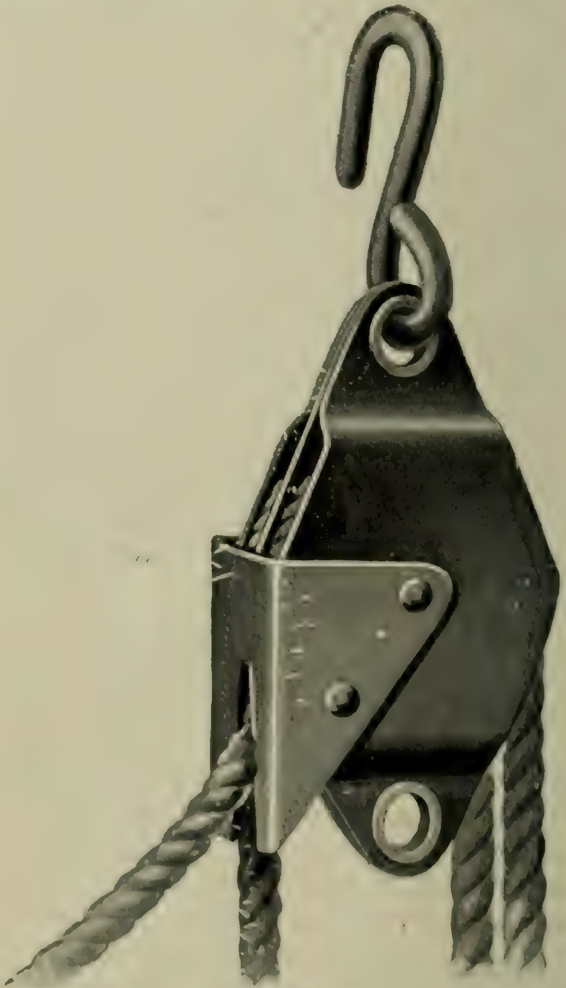
are always in engagement with the rear rail, to prevent the crane from tipping if a load should become fouled on a hatchway or other part of the vessel.

The crane is mounted on six wheels, four under the front and two under the rear. Anticipating the possibility of uneven settling of the wooden wharf, the wheels are carried in equalizers, so arranged as to compensate for any probable irregularities of track without straining the structure. The machinery for the various movements is placed in the base of the tower, adding to the stability of the crane and giving easy access for inspection. For convenience in shipping and erecting, each set of machinery is mounted upon a separate frame, which is easily handled and put in place. The crane has a regular working capacity of four tons, and a reach of 40 feet from the center line between rails to the extreme outer position of load. The total height of hoist is 70 feet, and the speed, hoisting with full load, is 150 feet per minute. The load can also be racked out and up at a speed of 150 feet per minute. The other two movements, travel and boom hoist, are relatively slow, being required only in setting the crane in position for service. The hoist is operated by a 65 H.P. motor, the rack motion by a 40 H.P. and the travel and boom hoist by 24 H.P. and 8 H.P. motors respectively. Automatic switches are provided to prevent overtravel in hoisting and racking out, also an overload switch for the hoist machinery. All movements are under the control of one operator, whose cab is located as to give him the best view of his work.

The crane weighs nearly 50 tons, and with the boom in the raised position it stands 90 feet above the wharf. The motors and controllers, as well as all structural work and machinery, are the product of The Shaw Electric Co.'s plant at Muskegon.

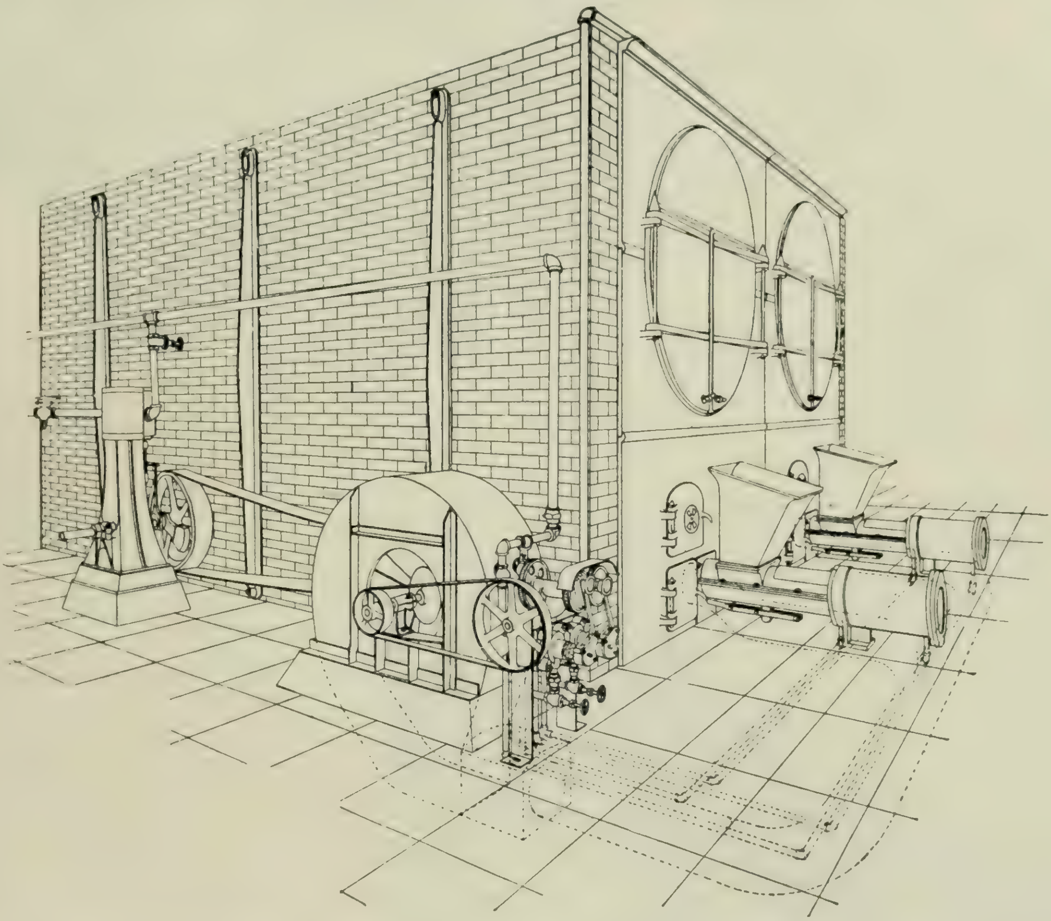
The Lane "Junior" Tackle Block.

THE accompanying cut represents a new block which Lane Bros. Co., Poughkeepsie, N. Y., have designed and placed on the market to supply the increasing demand for a thoroughly first-class article, at a lower price than the regular Lane standard tackle block. The "Junior" has a case made entirely of steel which is finished in black enamel or galvanized as desired. An efficient lock is supplied when required. This does not in any way interfere with the regular use of the block, but may be brought into action at any time by simply stepping back a short distance. No check cord is required and no part of the locking device touches the rope at all when not in actual use holding the load. These blocks may be used equally well horizontally or in any desired position. The Lane block holds the load anywhere, in any position, for any length of time. It is a great deal more convenient for handling comparatively light loads than the cumberous chain block, being much lighter and quicker in action as well as less expensive. It is just as easily handled as the ordinary block having no locking attachment, and adapted to just as many uses, but, what is more important, it is applicable to all sorts of requirements that the common blocks cannot meet at all. The same help can do more work if equipped with these blocks than with the common kind.



Automatic Mechanical Stoking.

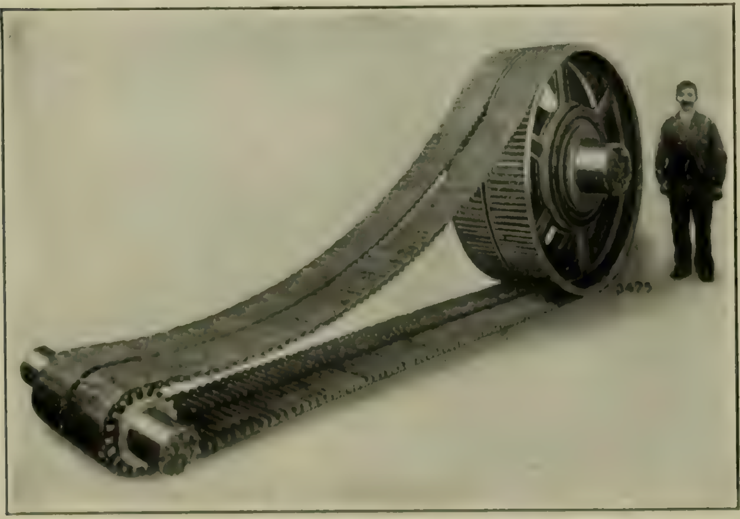
A SYSTEM of mechanical stoking, automatic in the truest sense of the word, because automatic in the application of those principles vital to the economically successful utilization of fuel, describes the Jones "under-feed" system. The proportioning of the fuel supply and the air supply is a requirement absolutely necessary to produce a state of perfect combustion. This is a principle of physics and chemistry apparent in the burning of the common oil lamp, the ordinary Welsbach light, the kitchen gas range, etc. The Jones "under-feed" system applies this same principle in mechanical stoking, but going a step in advance, the steam pressure itself automatically proportions the fuel and the air to each other and to varying loads, therein exercising automatic control in its truest and most absolute sense. This feature of automatic regulation is secured through that portion of the Jones stoker equipment known as the Cole automatic attachment. The engine driving the blower is equipped with a regulating valve which, as the steam pressure rises above a certain point, throttles the supply of steam, thereby slowing down the engine and the speed of the blower, and consequently diminishing the output of air, or *vice versa*, should the steam pressure fall. On a stand located close to the blower is a bank of rotary disc valves, dependent in number upon the number of stokers installed, since each valve controls the admission of steam to a stoker cylinder. These valves are driven by a belt connected to the blower, the relative sizes of the two pulleys being calculatd so as to maintain the proper proportion between the output of the blower and the rate of fuel feed. The immediate effect is to diminish the amount of air and to decrease the quantity of fuel admitted to the furnaces if the steam pressure rises, and on the contrary, to increase the amount of air and to increase the quantity of fuel if the steam pressure falls. The operation secures a correct proportioning of fuel and air, producing a clean and perfect combustion and eliminating smoke. It limits steam production and consumption of fuel to actual requirements, and being so completely au-



tomatic responds immediately to fluctuations in load, without attention or effort on the part of the operator. The Jones stoker is manufactured by the Under-Feed Stoker Company of America, Marquette Building, Chicago.

Powerful Renold Silent Chain Drives.

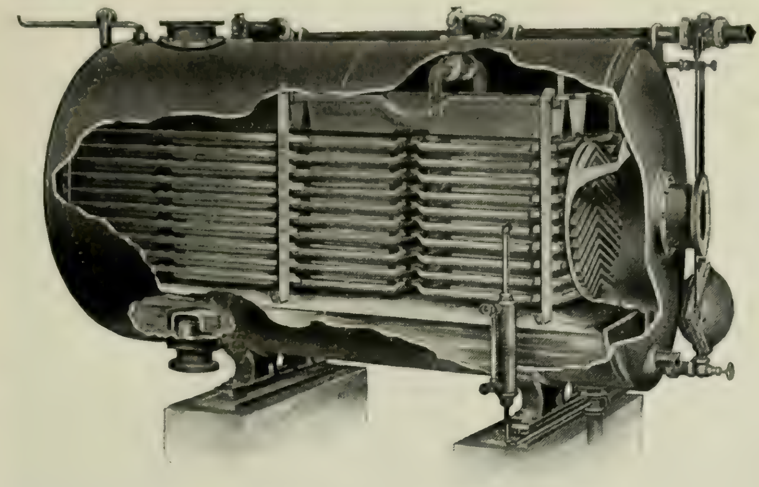
As showing the rapidly increasing appreciation of the many advantages of Renold silent chain drives for high-speed power-transmission, we mention two recent applications to different conditions in widely separated parts of the country. To the Seattle Brewing and Malting Company, Seattle, Wash., belongs the distinction of installing the largest Renold silent chain machinery; a single strand Renold silent chain drive having been put in to operate a Worthington centrifugal pump from a horizontal turbine at a speed of 1,755 feet per minute. The two chains for the brewing company are run side by side on single wheels 14 feet from center to center, the load being uniformly distributed by Dodge spring-centers on the driven wheel. The speed is 1,100 feet a minute. The pump drive measures 11 ft. 7 in. center to center, and has a capacity of 225 horse power.



A Renold "silent" chain gear, as it is termed by the American manufacturers, the Link-Belt Company, consists of the "silent" chain and specially cut sprocket wheels. The links, stamped from high-carbon steel, are held together by hardened steel pins and bushings which make a practically indestructible joint and one which provides the greatest possible bearing surface for a given width of chain. It is due to the peculiar formation of the links and their method of contact with the wheels that the defects and racket common to the ordinary drive-chain are overcome. The stretch that may result from wear of the teeth is compensated for by the chain automatically assuming a larger pitch diameter while providing the surest possible contact with the driving and driven wheel, one-half the circumference of each wheel being always in mesh. As this continues to be the case, even when the chain becomes worn, it is evident that its maximum efficiency will be maintained, although the demands may be severe enough to completely incapacitate ordinary drives. The chain will run in either direction with uniform, quiet and positive action and is not adversely affected by hot or cold temperature, damp or oily situations.

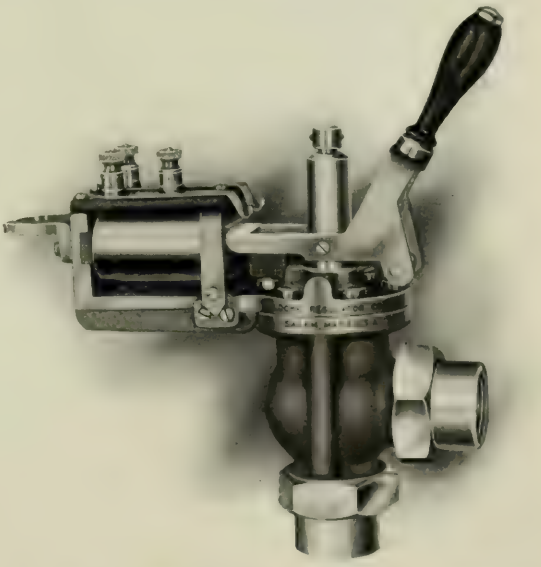
Hoppes Feed-Water Heater and Purifier.

We illustrate herewith a Hoppes feed-water heater, class "R," in sectional side and sectional end views. Several new features have been embodied in the design of this heater, the principal one being the overflow dam as shown at the rear or exhaust inlet end. The form of shell used is cylindrical, the heads being bumped to a radius equal to the diameter, the object being to avoid flat surfaces so as to prevent pulsations due to the impulses of the exhaust. In class "R" the lower portion of the shell is cast iron, the upper portion being made of heavy flange steel. Class "T" is the same as class "R," with the exception that the entire shell is made of cast iron. The heater is provided with a series of multi trough-shaped cast-iron pans arranged in tiers, the object being to secure a large amount of heating surface. Owing to the trough shape given the pans, the water in flowing over the sides and edges follows the under side or bottom to the lowest point before dropping into the next pan below. The exhaust steam enters the heater through a very large oil catcher and in passing through the heater comes in direct contact with the water flowing in a thin film along the under side of the pans, and as this process continues regardless of the amount of lime formation, the water is always heated to the highest possible temperature until the heater is ready for cleaning. The lime and other solids which may be held in solution in the water, will, when liberated by the heat, form mostly on the under side of the pans, while matter in suspension will settle inside them. The water is introduced into the heater through a balanced valve controlled by a float in an independent float box and is evenly distributed in the feed troughs by pipes shown in the top of the heater. Each branch of the interior feed-pipe is provided with a reduced opening where it is flanged to the tee at the top, this opening being of correct size to distribute properly the water in the various pans. The distribution of the water by means of orifices of given size is not only made use of in each heater, but is available for feeding two or more heaters in multiple, and it has been found to be very effective. When it is desired to change the size of the orifices, this can be done by means of removable discs having the proper size openings and placed between the flanges of the "L" shaped feed-pipes and the tee at the top. These heaters are manufactured by the Hoppes Manufacturing Co., of Springfield, O., in sizes ranging from 50 to 32,000 horse-power.



The Locke Engine Stop.

THE Locke Regulator Company, of Salem, Mass., have on their engine stop and speed limit system what they call an independent valve to shut down the engine when it begins to race, or when it is desired to shut off the steam in case of emergency or any accident. They put into the steam pipe between the boiler and the engine, usually flanged to the throttle, an ordinary poppet valve with a piston. The piston and poppets are of one solid casting. The piston is fitted loosely in a cylinder so that steam passing through the valve to the engine is of equal pressure on top and underneath the piston, thus balancing it. By suddenly exhausting the steam from the top of this piston the excess of pressure below the piston, that is the full boiler pressure, drives the valve to. Steam is exhausted from the top of the piston through the electric valve shown in the accompanying engraving. This is attached direct to the cylinder. The electric valve is always closed, but may be tripped by means of a snap switch or other circuit closer. In connection with this system the Locke "speed limit" is belted direct to the main shaft of the engine. This is set at any predetermined number of revolutions, usually the danger limit, and when the fly-wheel attains this number of revolutions the "speed limit" makes an electric contact which trips the electric valve, and steam is instantly exhausted from the main valve and the supply immediately shut off from the engine.

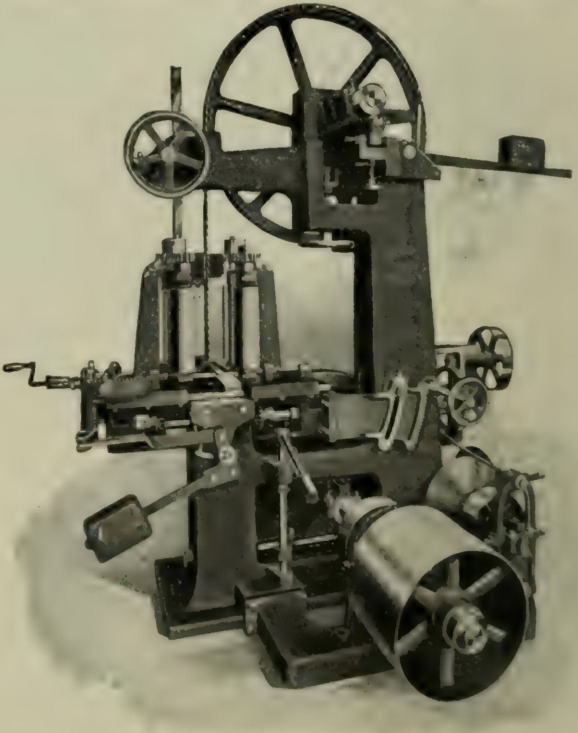


The Locke valve is so constructed that

the supply of steam through the main is not reduced in any way and there is no danger of wire drawing, the steam area of the Locke valve being larger than that of the supply pipe itself. The Locke system does away with any encumbrance to the throttle, which is left perfectly free and independent. Once the Locke stop has operated it can be almost immediately adjusted for a second operation, by closing the throttle, latching the electric valve and opening the Locke main valve by means of a hand-wheel attached to it. The Locke system, by making no attachments to the throttle valve, does away with the danger of closing so tight that it can be opened again only with great difficulty. It is, moreover, made in many different sizes and the price varies according to the size of the supply pipe to the engine that is to be equipped. The electric part of the system is so arranged that it can be tested out without shutting down the engine. The Locke Regulator Company make their stops in several different types adapted to different conditions. It is possible to place the shut-off valve back in the main so that several engines may be protected with one stop. This, of course, reduces the expense of equipping each throttle with a separate device. Another form is the "combined throttle and engine stop," which is substituted for the throttle proper, and at the same time has all the elements of an engine stop.

A New Band Resaw.

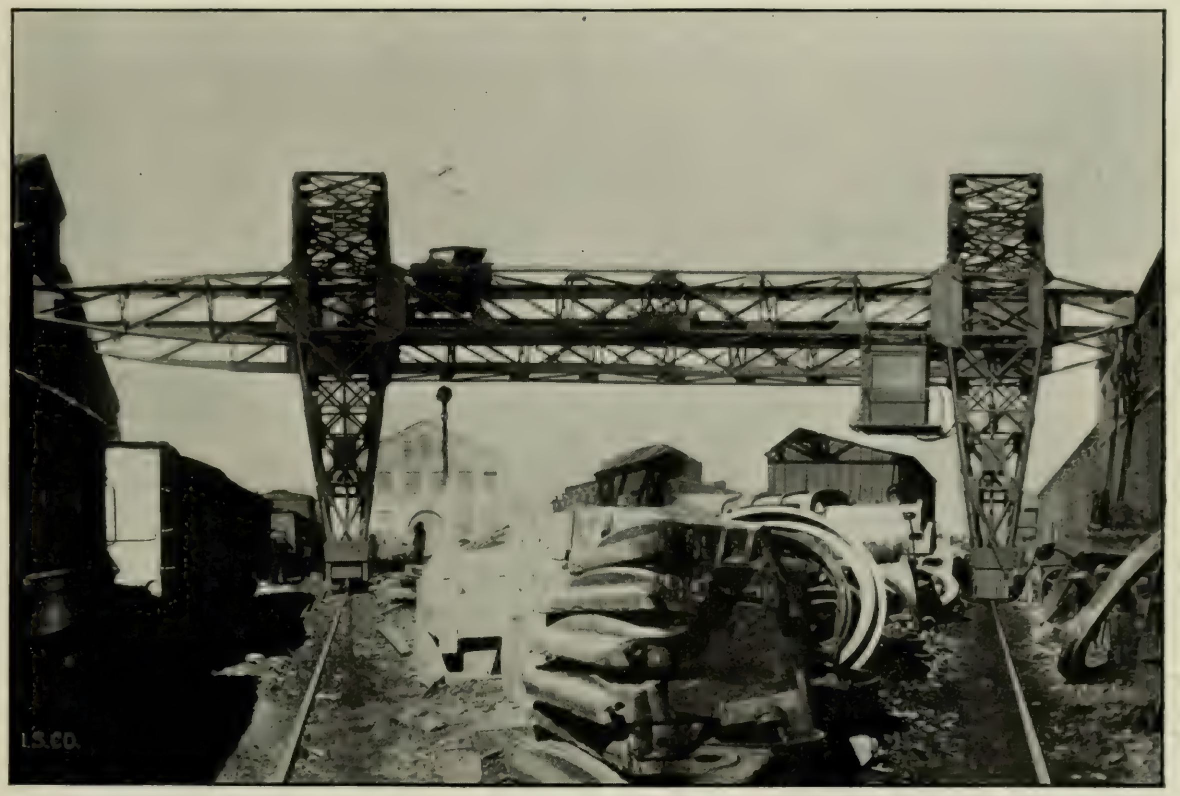
THIS is a new band resaw, embodying features that make is a splendid machine of medium capacity. The main frame is of improved design, cast cored throughout. The tension applied to the saw blade is the manufacturers' knife edge straining device, giving a perfectly even and uniform tension or strain upon the blade at all times, and acting instantly, thus greatly increasing the efficiency of the machine, and preventing the breakage of blades. The wheels are 42 inches in diameter, 3 inch face, entirely of iron and steel, improved in their construction; the lower one is made with solid web, cast hollow, circulating less dust and giving greater weight and momentum, and thus controlling the motion of the upper wheel. The upper wheel has a lateral adjustment made without stopping the machine, to cause the saw to run in its proper path on the wheel. The feed works consists of four rolls which open to receive any thickness of material up to 8 inches, and up to 24 inches wide. The rolls are self centering, also fitted with an improved device for quickly reducing thick lumber into picture backing, panels, etc., as the inside feed rolls may be instantly moved to or from the saw by means of a lever convenient to the operator, and gauged by a quadrant spaced in the most accurate manner, by eighths of an inch. The rolls may be tilted to an angle of 12°. The speed is controlled by an improved variable friction feed. The improved anti-friction saw guide is mounted on a square guide post, so designed that it cannot get out of alignment, and is counterweighted, making it easy to raise and lower. For further information regarding the tool, write the manufacturers, J. A. Fay & Egan Co., 212-232 West Front Street, Cincinnati, O.



Niles Gantry Crane.

WE present herewith description and illustration of a large Niles electric traveling gantry crane, built by the Niles-Bement Pond Company of New York, and lately installed at the South Chicago Works of the Illinois Steel Company.

The crane is of 15-tons capacity, and runs on a track laid on the ground 56′ 0″ center to center of rails with a cantilever extension on one end of 12′ 9″ and 28′ 3″ on the opposite end, making the total length of girders 97′. The girders are what might be termed lattice construction with auxiliary brace. The main girders are built up with universal mill plates and angles to form the top and bottom chords, fastened together by lattice angles. The auxiliary girders are of lattice construction so arranged as to secure great strength and rigidity and minimum wind surface, which is of course important in yard cranes exposed to the elements.



The truck axles are of steel, accurately turned and ground, and revolve in bronze bearings with waste cellars beneath. The truck wheels are forced on by hydraulic pressure and prevented from turning on the axle by carefully fitted straight feathers or keys. The bridge drive shaft is connected to each pair of equalizing truck wheels by mitre gears, the vertical shafts being supported by roller thrust bearings. The bridge trucks are equipped at each end with a pilot to aid in removing any obstruction that may be on the track.

The bridge drive motor is located on the girders approximately in the center between the runway tracks, where it is connected by a spur gear and pinion to the steel bridge drive shaft, which is carried in cap bearings and uniformly supported the entire length. This shaft is of sufficient strength to transmit the entire effort of the motor and to skid the wheels on the track. The cage is inclosed to protect the crane operator from the weather and fitted with drop windows and sliding door. A steel ladder is attached to one of the supporting columns reaching from the ground to a platform on the floor level of the cage from which access is had to the cage through the sliding door mentioned above. This platform is surrounded by substantial hand rail, and an additional ladder is furnished reaching from the cage platform to the foot-walk extending the entire length of the bridge drive shaft, allowing easy access to all gears and bearings. The bridge drive motor is equipped with a powerful foot brake of the Post type, the brake shoes being withheld from contact with the brake drum except when applied by the operator, thereby eliminating friction and reducing the wear on the brake shoes and drum to a minimum. This brake is operated by a foot lever located conveniently in the cage.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Corrugated Bars.

Expanded Metal and Corrugated Bar Co., St. Louis.—Catalogue containing illustrations of work done with corrugated bars, some information about them and simple formulæ and tables for use in designing. The book is well printed and illustrated. 10 by 8½ in.; pp. 112.

Disk Wheels.

Buffalo Forge Co., Buffalo.—Folder describing electric disk wheels, together with prices, sizes, etc. Illustrated. 3½ by 6½ in.; pp. 4.

Drill Chucks.

T. R. Almond Mfg. Co., Brooklyn.—Well printed catalogue illustrating and describing drill chucks. Right angle transmission, turret heads, flexible arms for electric lights and flexible steel tubing are also treated. 5 by 7½ in.; pp. 30.

Drill Grinder.

Wilmarth & Morman Co., Grand Rapids.—Catalogue illustrating and describing drill grinders. 6 by 9 in.; pp. 32.

Dump Wagons.

Troy Wagon Works Co., Troy, Ohio.—Booklet giving the results of a test of a dumping wagon made to ascertain its strength under varying conditions. Illustrated. The tests were made by prof. W. K. Hatt of Purdue University. 3½ by 6½ in.; pp. 24.

Electric Fans.

Sprague Electric Co., New York.—Catalogue No. 35 is well printed in two colors and contains an illustrated description, with prices, of electric fans. 7 by 9¼ in.; pp. 34.

Fans.

Green Fuel Economizer Co., Matteawan, N. Y.—Pamphlet discussing artificial drying in general and deals with the different ways in which the brick and tile can be dried by the use of heat from live or exhaust steam. 6 by 9 in.; pp. 16.

Gas and Gasoline Engines.

John V. Rice, Jr., & Co., Bordentown, N. J.—Catalogue containing an illustrated description of gas and gasoline engines, together with prices. 9 by 6 in.; pp. 34.

Liquid Fuel Equipment.

W. N. Best American Calorific Co., New York.—Catalogue No. 1 treats of liquid fuel equipment for marine and stationary boilers. Illustrated. 6 by 9 in.; pp. 32.

Locomotives.

American Locomotive Co., New York.—Catalogue illustrating and describing different designs of 8-wheel or American type passenger locomotives. 9 by 6 in.; pp. 60.

Machine Tools.

American Tool Works Co., Cincinnati.—Sectional catalogue giving a brief illustrated description of lathes, shapers, radial and upright drills, planers, etc. Also gives the sizes in which they are built. 8½ by 11 in.

Brown & Sharpe Mfg. Co., Providence.—Catalogue, pocket size, illustrating and describing milling machines, gear cutting machines, screw machines, cutters, etc. Bound in cloth and fully indexed. 4 by 6 in.; pp. 496.

Magnetic Chucks.

O. S. Walker & Co., Worcester.—Catalogue devoted to an illustrated description of magnetic clutches. 6 by 9 in.; pp. 30.

Mine Gages.

Wellman-Seaver-Morgan Co., Cleveland.—Catalogue giving an illustrated description of mine gages, skips, ore cars and sheaves. 6 by 9 in.; pp. 40.

Motors.

Barriett Electric Mfg Co., Cincinnati.—Bulletin treating of direct current motors and generators. 7½ by 10 in.; pp. 12.

Nickel Steel.

Orford Copper Co., New York.—Pamphlet containing a paper entitled "Nickel Steel: Its Properties and Applications," by Albert Ladd Colby. Reprinted from the Proc. of American Society for Testing Materials. 6 by 9 in.; pp. 30. Also a booklet giving a list of the purposes for which nickel steels have been successfully applied.

Power Chains.

Diamond Chain & Mfg. Co., Indianapolis.—Catalogue containing an instructive treatise on power chains and sprockets. The chapter on power transmission explains the advantages of chain gearing, and draws comparison with belting, bevel gears, etc.

Pumps.

W. & B. Douglas, Middletown, Conn.—Catalogue containing an illustrated description of electrically driven pumps. Also contains tables giving capacities, prices, etc. 7 by 5 in.; pp. 32.

Rock Drills.

Ingersoll-Rand Co., New York.—Catalogue No. 45B illustrates and describes rock drills for mining, tunneling, quarrying and general rock excavation. 6 by 9 in.; pp. 96.

Roofing Slate.

J. K. Hower, Slatington, Pa.—Small booklet treating of slate as a roofing material, together with tables showing regular sizes and prices. 3½ by 6 in.; pp. 18.

Separators.

Power Plant Specialty Co., Chicago.—Booklet illustrating and describing two stage steam separators. 3½ by 6 in.; pp. 16.

Small Tools.

Pratt & Whitney Co., Hartford.—Well-printed catalogue containing a brief illustrated description, with sizes and prices, of taps and dies, milling cutters, ratchet drills, lathe tools, drills, reamers, etc. 5 by 7½ in.; pp. 216.

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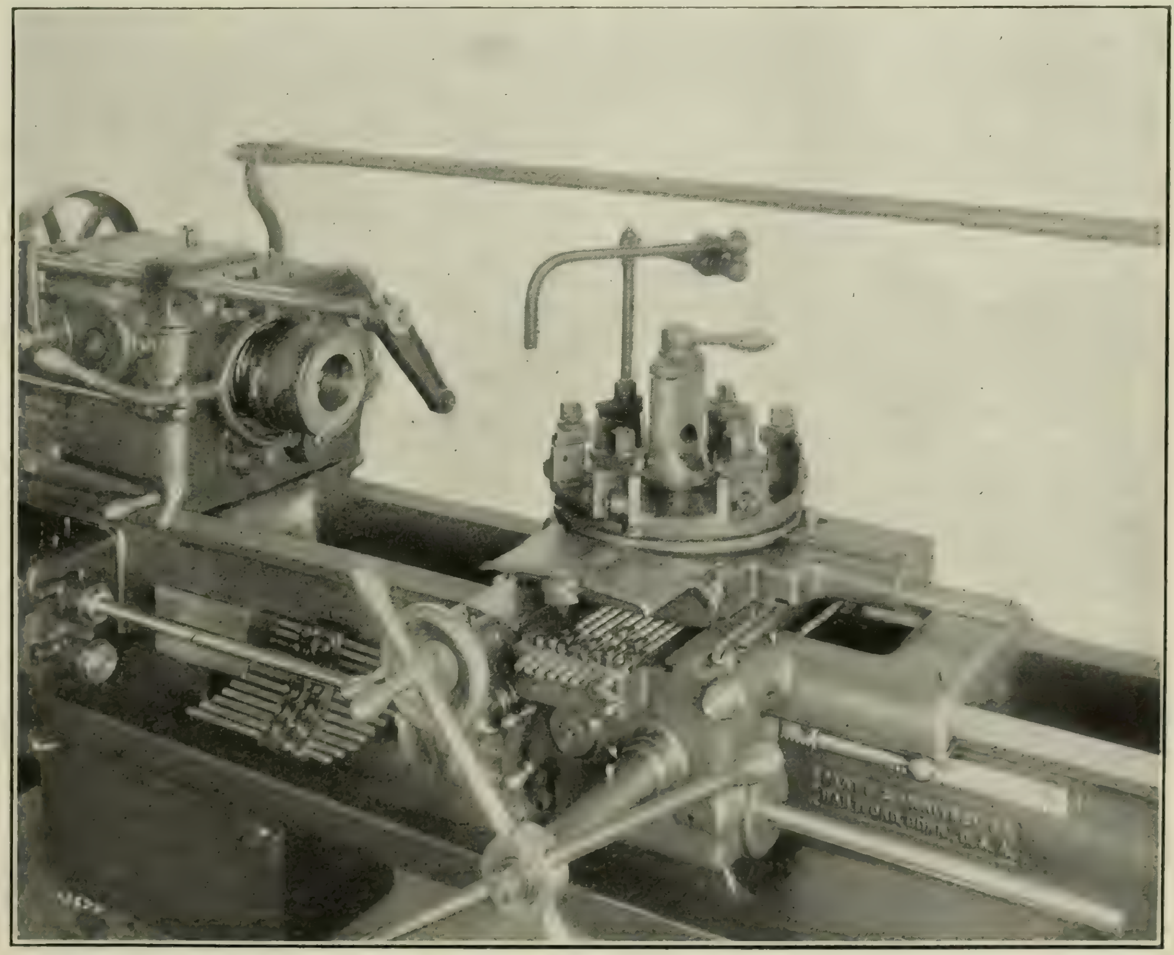
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

"Open Turret" Lathe.

THE new Pratt & Whitney 2½ x 26 in. "open turret" lathe is a universal machine suitable for doing a great variety of work from the bar and on forgings and castings, without continually requiring special appliances and expensive cutting tools. To accomplish this purpose many new features, including a cross sliding turret, have been introduced. This machine possesses practically all the flexibility and adaptability of the engine lathe. The extreme rigidity, powerful spindle drive, quick changes of speed and feeds, heavy cross feeding turret and numerous adjustable stops, admit of narrower limits of error, as well as a marked reduction in the cost over work produced on the ordinary turret or engine lathe. The machine has a stiff head, with constant speed arranged for either direct-connected motor or countershaft drive by means of a single pulley. The turret is mounted on a slide, having both positive power and hand longitudinal and traverse directions. The machine is recommended for bar work up to 2½ in. diameter by 26 in. long, for castings up to 14 in. diameter and for cylindrical operations on work within these dimensions. An unusually heavy spindle of special steel, with cylindrical bearings, runs in bronze split sleeves. The thrust of the spindle is against an independent upright, cast solid with the head, and insures against any springing tendency under heavy end cutting strains. Provision is made for



taking up wear of spindle and end thrust. The direction and variation of the spindle to the work holding spindle are obtained by levers operating friction clutches. It is impossible to connect more than one set of gears with the spindle and main driving shaft at the same time.

The gears are of extra heavy pitch and of ample width to withstand safely the hardest usage. The head, which is stationary, is of box construction, the gears running continually in oil. The manufacturers, Pratt & Whitney Co., Hartford, Conn., will be glad to furnish further particulars.

Fireproof Residence Construction.

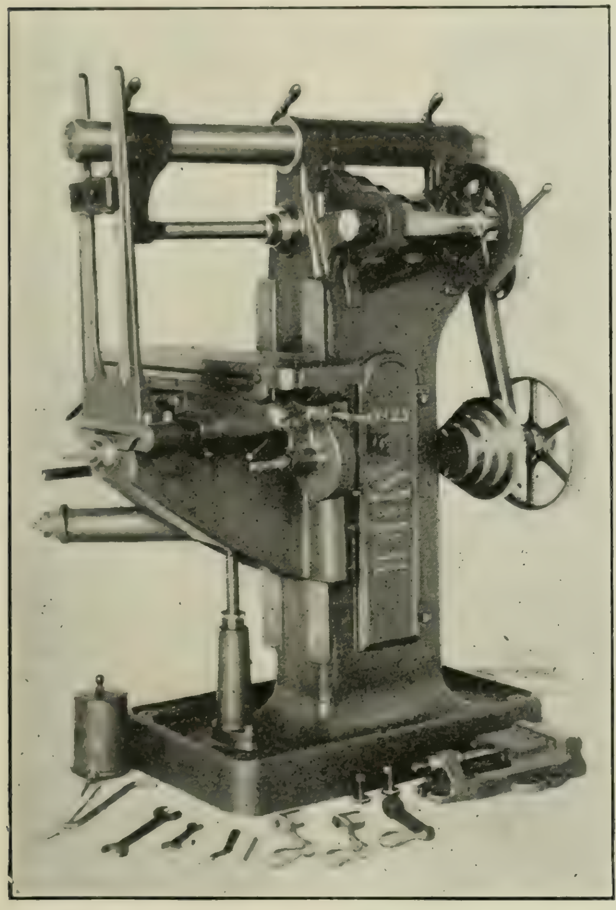
THE prospective homebuilder in his consideration of the various types of construction and materials available must ultimately base his decision on the bed rock of economy, namely, the most to be obtained in durability, beauty and comfort, from a given expenditure. In choice of plans for the proposed structure individual taste in choice of design in both exterior and interior arrangement may enter to an almost unlimited extent without serious impairment of the finished structure. Before this point is reached, however, comes the question of fireproof vs. old style construction. Here the builder is confronted by the necessity for a radical decision. Since fireproofing methods effectively and economically applied to residence construction are a rather recent development in the progress of the building industry, the ignorance of methods and comparative costs which generally obtains on the part of the laity should not be occasion for wonder. Therefore, in this connection, a word of comparison between old and new methods of construction may not be amiss.

The figures as given herewith were compiled by the New Century Contracting Company, 1 Madison Avenue, New York, from plans actually executed and, while of necessity but approximate, furnish authentic data of unusual value.

The New Century type of construction calls for terra cotta tiles laid in Portland cement, sustained by reinforced concrete girders and beams. Since the nearest analogy to this type of construction is found in the familiar brick and frame dwelling a comparative statement of approximate costs of the two is especially interesting. First as to floors, on a square foot basis: in the brick and frame structure the floor estimate must include the items of timber, finished floor, under floor, plastering (3 coats), lathing, cross furring (ceiling), bridging and paper. These items distributed in approximate proportion give an average estimate of 39½c. per square foot. In the opposed New Century structure, floor estimates include concrete and tile, finished floor, plastering ceiling (2 coats), and sleepers, totaling 32¾ cts. As to walls: the former, including brick veneer, timber, sheathing, plastering, furring, bridging and tie, lathing and paper totals 47 cts. per square foot, while the latter method, estimating on tile block, brick veneer and inside plastering gives 46 cts. Therefore, the brick and frame structure presents a total cost per square foot of 86¼ cts., while the New Century structure shows only 78¾ cts. per square foot. To the total saving to the builder of 11½ cts. —approximately 10 per cent.—of the latter method must be added the credit of absolutely fireproof qualities, together with the fact that it is air-tight, and that hollow tile, being a perfect non-conductor, retains cool air in summer and warm air in winter. This obviously gives in the one season added comfort to the occupant and in the other the advantage of economy in fuel consumption. It is worthy of note that, with specifications as above, both the exterior and the interior appearance of the two structures is identical.

Horizontal Milling Machines.

THE No. 25 and No. 26 milling machines, manufactured by the Becker-Brainard Milling Machine Co., Hyde Park, Mass., are made in two styles, backed geared and not backed geared respectively. In their design special attention has been paid to the requirements of the manufacturer of small machine parts, which are produced in large quantities, such as are found in small arms, typewriters, sewing machines and electrical works. In bringing out the new model especial attention has been given to the feed works, that they may be able to withstand the full power of the driving belt, and at the same time give good service in the rough usage to which these machines are subjected. This new feed is driven by belts which get their motion from the spindle of the machine by means of a train of gears, so arranged that the velocity of the belt is sufficient to drive all feeds that the main belt will stand. The changes of the feed are obtained by four step cones and by interchanging the feed driving pulleys on the back of the machine, giving in combination eight changes from .007 to .100.



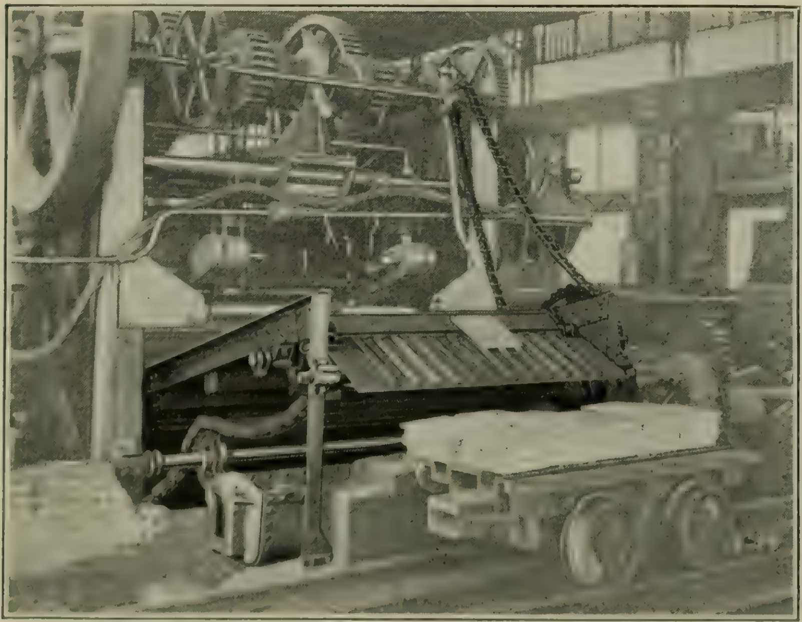
The table is operated by a worm and hobbed rack, the worm being driven by means of a worm gear of large size and a worm of coarse pitch. The arrangement for disengaging the feed is by a novel worm mechanism by which the worm is thrown out of mesh with the gear, and leaves in a path at right angles with its axis, overcoming the objection of the old style gravity drop worm of clinging to the gear by friction alone. It also equalizes the wear on the worm gear teeth. The worm is also engaged and thrown out of mesh by the same lever, making in all a neat, convenient and positive method of automatically disengaging the feed and stopping the travel of the table at a predetermined point. The table is also supplied with a hand quick return of 4 to 1 ratio, allowing it to be returned to the original position in the least possible time.

The knee of the new model has been lengthened sufficiently so that a harness brace may be used for the arbor and still have a cross range for the table equal to that of the old style machines. This harness is especially worthy of notice and makes for convenience as well as rapidity. It consists of a brace which is gibbed to the knee slide; a clamp that is fastened to the arbor support yoke in a manner that allows it to be swiveled around its centers, allowing the brace to be removed without removing any bolts. This clamp is made fast to the brace by friction which gives a more rigid hold than the old style bolt, washer and slot arrangement, at the same time allowing of a much stiffer brace. The convenience of this device will be at once appreciated by the operator. The arm, which is a solid steel bar, is adjustable lengthwise.

These machines are equipped with a rigid box knee and with a telescopic elevating screw, allowing the machine to be set in any position without regard to beams on floor construction, as the screw does not project below the floor line. The base of these new model machines has been designed on the same lines as the other Becker-Brainard machines, which are extra heavy, absorbing all vibration. The spindle cone and back gears are of the standard Becker-Brainard design, the spindle bearing being cylindrical in form, the wear being taken up by concentric compensating bronze boxes. The appearance of the machine has in no way been neglected, since new patterns were made throughout.

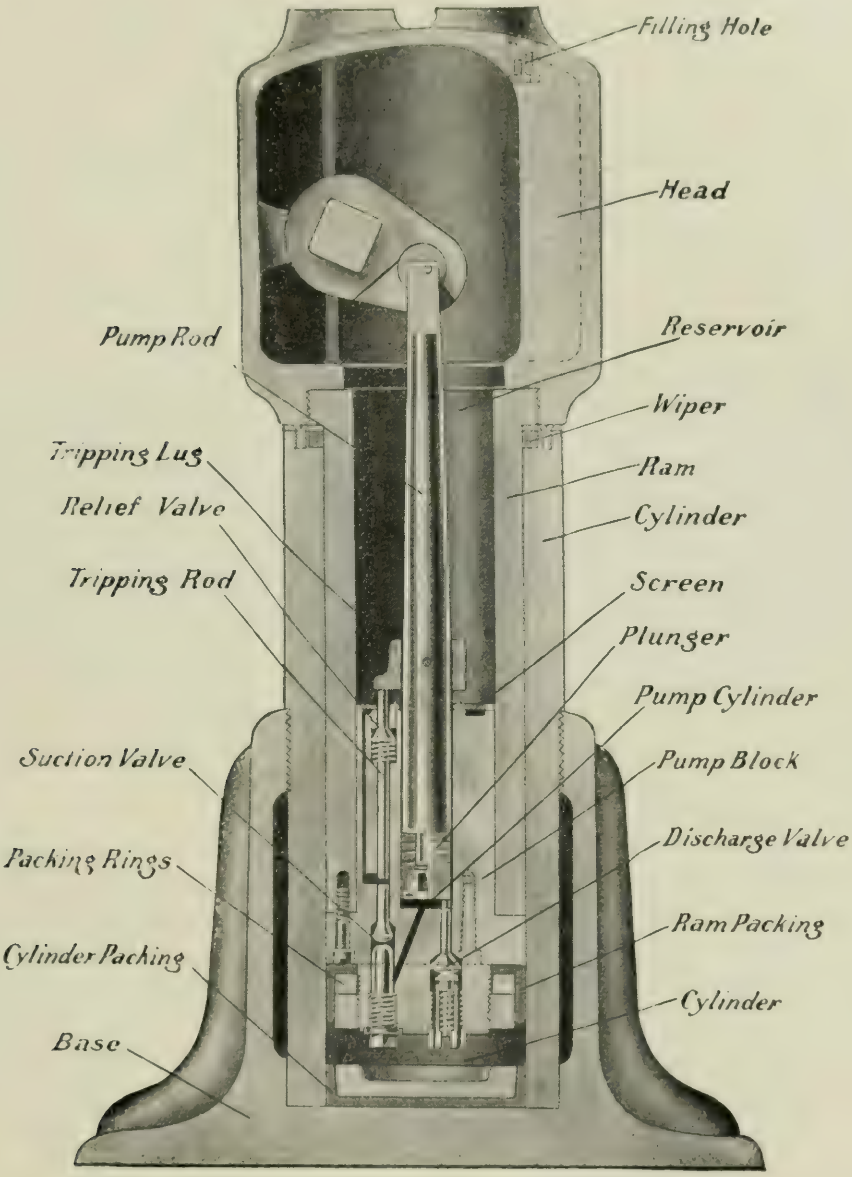
Billet Conveying.

ONE of the oldest and most prominent firms closely identified with the rise and progress of the steel industry in America, is the Alan Wood Iron & Steel Company, whose establishment at Conshohocken, Pa., dates back eighty odd years. During these years this firm, along with other pioneers, has witnessed the introduction of many improvements in manufacturing and seen many mechanical devices for the facilitating of production and handling put into operation. The electrically-operated conveying equipment for expediting the movement of hot and cold billets at their Ivy Rock mill, indicates that even if the firm is old, as years are counted, it is not lacking in up-to-date equipment for increasing facilities. A look into the rolling mill shows that when the ingot is of equal heat from center to corners, it is brought to a transfer table by a crane. The movement of the table is controlled by an operator shielded from, but in plain view of, a tri-section roughing roll. The table takes the ingot to the roll, through which it is passed forward and backward several times. The lengthened ingot is then passed to the second section and again rolled, the proper length and thickness being finally obtained by a few passes through the third section of the roll. The cutting of the cold steel bars is done on the opposite side of the mill, the long bars being brought to the cutter by a transfer table controlled, as in the rolling, by a man in plain view of the cutter. When the current is turned on, a certain length of the bar passes under the cutter, the part remaining on the table being automatically clamped to hold the bar securely while being cut. The cutter comes down with a pressure of 500 lbs. in the cylinder and the severed portion of steel drops onto a Link-Belt inclined apron-conveyor which delivers the billets to cars running on a narrow-guage track.



A New Hyraulic Jack.

WE illustrate in cross-section a hydraulic jack of the inside pump type, such as is being quite extensively used by the United States and other governments for ship-yard and similar uses. This jack consists essentially of two hollow concentric steel cylinders machined to sliding contact with each other. The outer cylinder is fixed in a steel base and the joint packed with a copper cup to withstand great pressure. The inner cylinder is closed at the top by the "head" and at the bottom by the "pump block," thus making a reservoir, in which the filling liquid is held. The pump block derives its name from the small pump contained therein and connected through the piston rod to the lever outside. Movement of the lever forces the liquid through suitable valves into the space between the lower end of the pump block and the bottom of the outer cylinder, thus pushing the base and head apart with a gradual movement. The delicate parts of a hydraulic jack must be designed to be secure from injury and if good material and the highest mechanical skill are not incorporated into their manufacture, they will become useless after short service. Provision must be made to prevent leakage, to prevent undue wear and to provide easy access to the interior, especially to the suction and discharge valves in the pump block. Most trouble from leakage in hydraulic jacks is caused, first, by the liquid running from the filling hole when not in use and laid in a horizontal position, and second, from leaking or blowing out of the packing at the lower end of the outer cylinder. In older types of hydraulic jacks the filling hole contained a filed groove to allow the air to enter and escape as the ram was raised and lowered. While the purpose was accomplished, liquid was found to escape also when the jack was resting in a horizontal position. In the jack we are here describing the filling device consists of a plug with two valves, one opening inwardly and the other outwardly, both being held to their seats by springs of sufficient stiffness to prevent the liquid escaping as the jack is laid down; but sufficiently elastic to allow the entrance and escape of air to and from the cistern as the ram is worked up and down. This free and uninterrupted movement of the air is essential to proper action of the pump.



Leakage at the cylinder end may result from two causes. As a rule a leather cup packing is used here and with this construction it is impossible to make a joint which will stay tight permanently. A leather packing may be perfectly tight when new, but it will shrivel and crack in time, causing a steadily increasing leakage which may result in an accident. The leather must be renewed frequently and as it difficult to reach the renewal is troublesome. In the Joyce-Cridland jack this cup packing is of copper, accurately turned to fit the bore of the cylinder. The inside of the cup is turned to a slight taper and after being placed in position a plug or packing ring having the same taper is forced into it, swagging the sides of the cup against the cylinder walls and making tight, permanent joints which need never be touched.

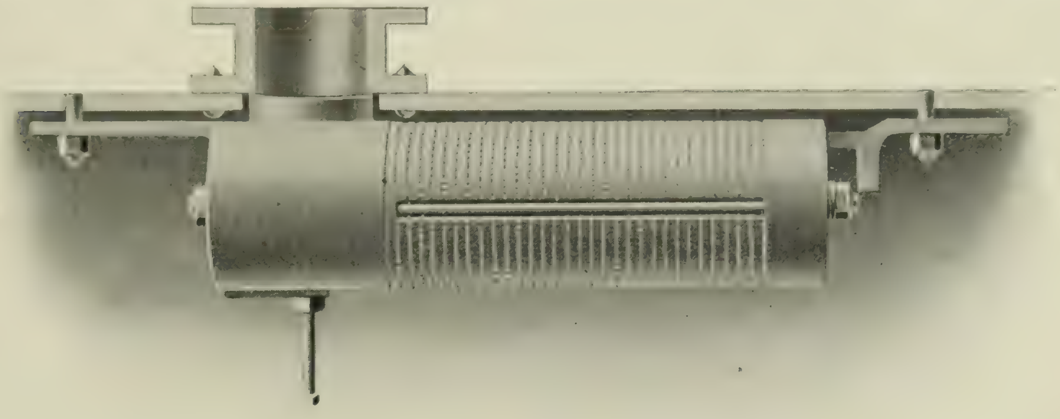
Another source of trouble heretofore existing in hydraulic jacks was due to dust, metal chips, or sand lodging on the ram when it was run out. If these were not removed on lowering they were carried down between the ram and cylinder, cutting grooves in both and doing irreparable damage to the jack. This trouble is prevented in the present jack by placing a wiper around the ram at the top of the cylinder. The wiper is saturated with oil and, in addition to wiping off any dirt from the ram as it passes down into the cylinder, lubricates the sliding surfaces, keeping them smooth and unscored. Should this foreign matter be allowed to enter the cylinder it would also cut the packing on the pump block and get under the valves rendering them leaky. The filling liquid may also contain dirt and grit and it is of the utmost importance that the liquid should be strained before it leaves the cistern on its way to the pump. Otherwise, the particles would soon prevent the proper seating of the valves, ruin the contact surfaces and otherwise interfere with the successful working of the jack. Trouble of this nature is prevented by a fine screen on top of the pump block, through which all the liquid must pass before reaching any delicate working parts and surfaces. Although there may be a considerable amount of dirt in the liquid it is prevented from reaching the valves. It may be noted from the cross-section that the suction valve is so located that the liquid may be taken from the extreme side of the bore of the ram. This permits the use of the greatest possible amount of liquid, a very important point when using the jack in a horizontal position, since the limit of the stroke depends upon the quantity of liquid which can be forced into the cylinder. The path of the liquid from the cistern to the main cylinder is as follows: When the pump plunger is raised, the suction valve is drawn from its seat and oil passes through the filter screen, through the passage shown in the extreme left of the pump block, past the suction valve and into the pump cylinder. When the plunger is lowered the suction valve closes, and the liquid forces the discharge valve open, passes by it and through the openings in the side of the valve cap into the cylinder, thus raising the ram. The illustration shows the plunger at the lower end of the normal stroke in which position the end of the pump rod touches the discharge valve stem and at the same time the tripping lug further up on the pump rod comes into contact with the suction valve stem. A slight additional length of stroke trips the jack, opens both these valves and allows the liquid to pass back to the cistern by the same channels through which it came. A lug on the operating lever coming in contact with a stop on the outside of the ram head prevents the stroke from being prolonged so far that the end of the plunger would touch the valve openings. The speed at which the jack may be lowered in this way is regulated by the pressure which the operator exerts on the lever. A valve is provided on the upper end of the tripping rod which prevents the pump taking air when the level of the liquid has fallen below the tripping rod. This valve is held by a spring of sufficient stiffness to prevent its unseating under the suction of the pump plunger, but it yields to the positive action of the tripping lug. The tripping mechanism is positive and under the direct control of the operator. It does not depend upon springs and cannot fail to act. In starting, the lever is turned with the lug pointing up, raised slightly to remove the pressure in the pump cylinder and to allow the suction valve to fall from its seat, then lowered slowly to allow the liquid to flow back from the pump cylinder to the reservoir.

For convenience in attention both the suction and discharge valves are placed in the end of the pump block so that by taking the ram out and unscrewing the caps which cover them they are immediately exposed. The discharge valve spring is protected by a casing and operates through a plunger which holds the valve normally to its seat. The casting protects the spring from the violent current of the liquid which in other makes tends to jam the unprotected spring out of shape.

The material which goes into the parts under strain must be of high tensile strength and only metals best fitted to resist wear are used. The cylinder and ram are forged and machined from solid high-carbon, open-hearth bar steel and the sliding surfaces contain no welds or seams. The head and base are crucible steel castings and the pump block is milled from a solid bar of Tobin bronze. The valves are made from phosphor bronze and are compressed to render them durable. The valve caps, the discharge valve plunger, and discharge valve spring are also of bronze, making a non-corrosive combination which will not cause trouble from the use of an improper filling liquid. Manufactured by The Joyce Cridland Co., Dayton, Ohio.

Dry Steam at the Boiler Outlet.

THE importance of dry steam at the boiler outlet is generally recognized, but it is a condition that in these days of quick-steaming and over driven boilers has been very hard to obtain. In consequence the steam plant of average size has been throwing away annually many hundreds of millions of heat units in the form of water drawn from the boilers with the steam. Figuring accurately, it is shown that this loss on a 500 H.P. plant in service ten hours a day for 300 days a year amounts to 4,869,000,000 heat units for every 1 per cent. of moisture delivered with the steam; this number of heat units, figured on a conservative basis, represents a consumption of 20 tons of coal per year. The Potter mesh separator has been designed to overcome this loss, by attacking the trouble at its source and separating the water from the steam before it reaches the boiler outlet. That it is successful in doing so is shown by a test, printed herewith, which speaks for itself, the conditions before installing the separator having been very bad. The test was conducted at the Great Northern Hotel, Chicago, Ill., March 15, 1907.



Time.	Gage Press.	Upper Man'r reading.	Lower Man'r reading.	Temp. Fahr.	Total. Manometer.	Quality, %.
4.00 P. M.	140	.3″	.3″	284	.6″	98.861
4.15 "	136	.3″	.3″	287	.6″	98.99
4.30 "	133	.3″	.3″	286	.6″	98.99
4.45 "	126	.3″	.3″	286	.6″	99.1296
5.00 "	127	.3″	.3″	286	.6″	99.107
5.15 "	130	.3″	.3″	287	.6″	99.103
5.30 "	125	.3″	.3″	285	.6″	99.092
5.45 "	126	.3″	.3″	284	.6″	99.019
6.00 "	127	.3″	.3″	285.5	.6″	99.0783
Average						99.0411

The accompanying cut shows the separator installed in a boiler, and it will be seen that it consists of a number of wire screens separated by light iron distance rings, the whole bolted together and connected up to the boiler outlet. The water carried in suspension in the steam is deposited upon the wire screens and returned by gravity to the water in the boiler. The separator, which is manufactured by the Potter Separator Co. of Newburgh, N. Y., is so constructed that distance rings and wire screens can be removed with ease, without breaking the outlet connection, for the purpose of brushing off the screens when they become too much coated with the foreign matter which is carried with the water. The need for this cleaning occurs only at long intervals.

Rope Drive for Machine Tools.

HITHERTO rope drive has been practically inadmissible for machine tools of the variable speed type, such as lathes, shapers, drills and drilling tools, because speed changes were usually procured by coned pulleys modified by throwing the back gear in or out. While a power rope can be shifted from one groove to another, the operation is so tedious and time-consuming that it cannot be applied to the often swiftly succeeding speed changes of modern machine shop practice. Hence, belts have generally been used for these carrying transmissions, though it is true that some lathes have for years been run with rope driving, using fast and loose rope sheaves or pulleys. Of late a number of single pulley drives have been introduced on tools of this class in which speed changes are effected by lever-controlled change gears. This system has the great advantage of increasing the power delivered to the cutting tool by high initial belt speed. With a constant speed for the driving shaft, cutting power is the same at high or low speed. Speed changes can be made very quickly and at a far greater range of changes than is obtained with stepped pulleys. In some of the latest types, increments of 10 per cent. are provided for. This design avoids the countershaft, and wholly eliminates the chance of injury to the workman in traversing the belt by hand. Injuries from this source are probably the most common in machine shops. Where wire belt lacing devices are used a wire end improperly tucked in has often caused frightful gashes to the operator's hand.

Though we are not accustomed in this country to see driving rope shifted from an idle to a working pulley, it can be done just as well with a belt, and is a matter of common occurrence in England. In a number of large cotton mills in the Lancashire district the power is conveyed from a line shaft running the whole length of the room to numerous ring frames by means of ropes instead of belts, the ropes operating on fast and loose pulleys mounted within guard boxes. This arrangement affords an excellent illustration of the reduction in weight on the shafting afforded by the substitution of rope driving for belting. The 3½ in. belts need pulleys 4½ in. face, while the ropes used are only 13/16 of an inch in diameter, and work in sheaves occupying with their flanges not more than one inch space laterally. In this combination a shifting arrangement is used, illustrated herewith, which could well be adapted for the drive of constant speed machine tools. The idle or loose sheave A has practically all of its flange cut away on the side towards the working or fast sheave B. To throw the machine into action, a curved rope shifter or fork is used, shown in section and perspective. It is bent to the curve of the sheave with just enough clearance above the sheave flanges to allow the rope to pass, and is operated with a pivoted hand lever as usual with belting. As the arm of the fork engages the driving side of the rope, it pushes the latter clear of its reduced flange onto the intermediate groove C, cut in the fast sheave. On this it gains a revolution while passing to its work, which insures a gradual starting or stopping and provides a most sensitive action. The shifter continuing towards the left, passes the rope into its working sheave B, whence it is readily forced out by reverse movement of the fork whenever the machine is to be stopped.

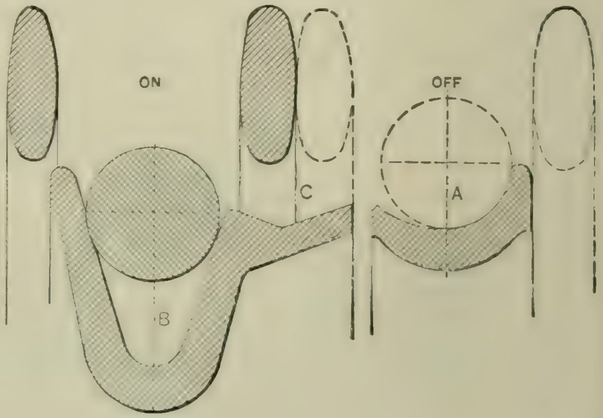


FIG. I.

Besides being exclusively used in English cotton mills, fast and loose driving is also used on lathes, mortar mills and in milling. It has been argued against rope driving of constant speed power tools provided with change speed gears that, because the driving shaft is usually directly above the machine, it would be necessary to use the American or continuous carriage and idler sheave. In answer to this it is claimed that the driving shaft may be set sufficiently to one side over the tool to make such an angle with the vertical that the multiple, or English system, could be used with sufficient natural tension. As the proposed innovation is a radical departure from existing practice, there is no need of adhering to any part of such practice not made intrinsically necessary by operating conditions. The principal reasons for placing driving shafts directly over lathes are to secure minimum lengths of belting, owing to its high cost and to keep the passage way between tools clear overhead. With rope drive the cost is so much reduced as compared to belting that even double the length will still be much cheaper than the belt. It might not be amiss to adopt an entirely different arrangement with rope drives of power tools by carrying the power up through the floor from line shafts run underneath. This would very much shorten the length of drives, clear the overhead space and enable the shifter or fork to operate on the driving side of the rope from below. It would have the disadvantage of increased fire risk from the openings made necessary in the floors. Another objection is that to secure sufficient speed, the sheave on the lathe would have to be so small in diameter that quite a number of ropes would have to be used, which would make the face of the sheave as wide, if not wider, than a belt pulley for the same power. As the drive contemplates a lathe equipped with gears for changing speed, this objection falls away because one single rope can carry a great deal of power to a tool provided with a large sheave, and as gearing is going to be used anyhow, the speed of the first driver shaft can be varied at will. That almost any machinist can lace a belt, whereas practically none can splice a rope is an objectionable feature of constantly diminishing weight, because, in the first place, a rope does not need to be spliced nearly as often as a belt needs to be laced, and with the rapidly increasing use of transmission rope, the practice is growing of having at least an expert drive rope splicer attached to each large industrial establishment.

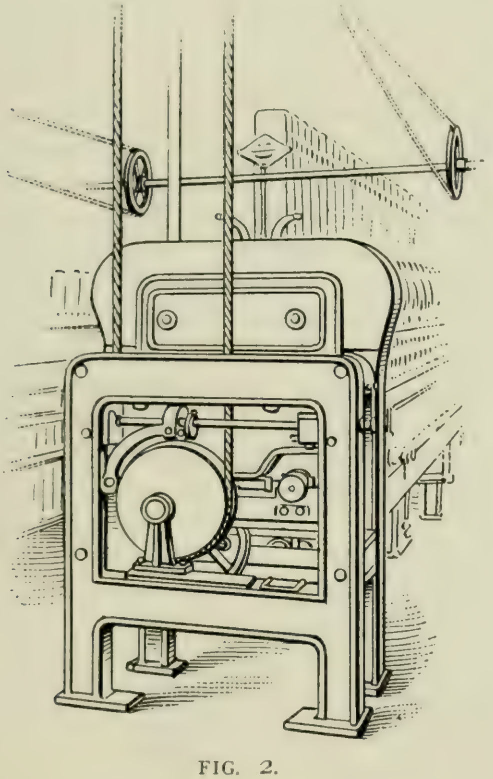


FIG. 2.

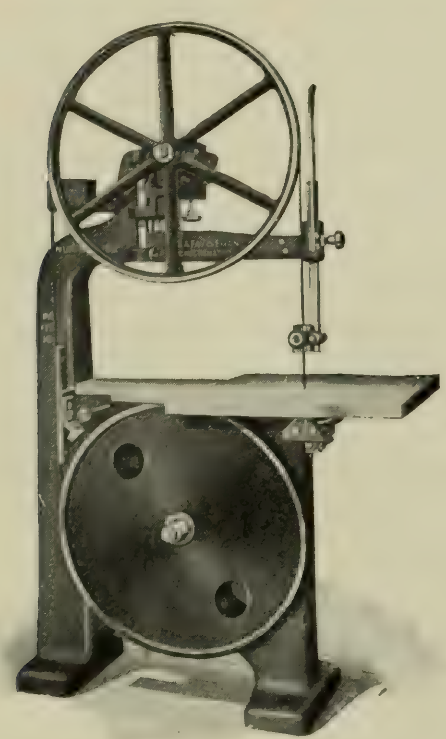
Rope transmission is comparatively so new a feature of engineering that its possibilities well deserve research and testing, because in every case where it has been tried under seemingly most unfavorable conditions, as in the Holsman automobile drive, it has given results justifying the enthusiasm of its sponsors.

Fay & Egan Band Scroll Saw.

THE No. 192 Fay & Egan band scroll saw machine will appeal strongly to those wishing a band saw for a large variety of light or heavy work. The column is a substantial cored casting, its form being such as to give greatest freedom of movement to the operator. The wheels, which are 33 in. in diameter, are taper fitted onto the shafts, which run in long bearings. The upper wheel is carried on a saddle vertically adjustable by means of a hand-wheel, convenient to the operator, for varying the length of the saw blade. The bearing is mounted on a knife edge and fitted with the patent sensitive straining device, shown herewith, maintaining an even tension of the blade at all times.

The lower wheel is solid webbed, and its weight gives it a momentum which continually controls the lighter upper wheel.

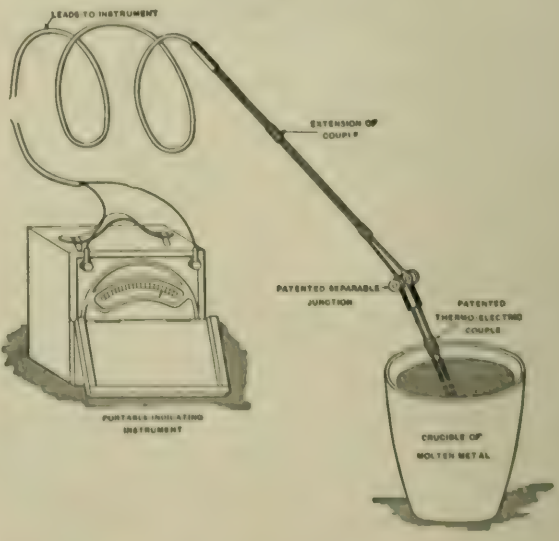
The machine has an iron table 24 x 26 in., which may be tipped to any angle up to 45 degrees and is securely locked in any position. The height from the floor to the top of the table is 37½ in. The upper guide, which is the new roller type, is carried on a square bar, insuring permanent alignment. It has a vertical adjustment for any distance up to 12 in. above the table. The height of the machine over all is 6 ft. 9 in. The manufacturers, J. A. Fay & Egan Co., 212-232 West Front Street, Cincinnati, O., will send further details on request.



A Portable Pyrometer.

In manufacturing processes and in metallurgical work molten metals and alloys are extensively employed, especially for the making of castings from moulds and it is important that the metals be mixed, alloyed and poured at the proper temperatures in order to obtain the best results. The special form of pyrometer described here has been designed to meet the practical requirements of every day shop practice. The portable indicating instrument may be carried in the hand and within two or three seconds the temperature of the molten metal may be taken. The possibilities and great value of an instrument of this kind will be fully appreciated by those who are interested in foundry work of any description. The outfit complete consists of a portable indicating instrument connected to a special thermo-electric couple, the two elements of which are disconnected and left without insulation. When the tips of these elements are slightly immersed into the molten metal an electric connection is made and the reading on the instrument will be the same as if the couple had been originally joined. The general arrangement of the parts forming the outfit for this class of temperature measurements is shown in the accompanying diagram as it would be applied for taking the temperature of a crucible of molten metal just before pouring. The advantage of this plan is that the tips of the wires forming the elements almost instantaneously assume the temperature of the molten metal and time lag error is eliminated. This form of couple has been most successfully applied to the measurement of molten metals as cast iron, copper, aluminum, brass, bronze and other alloys.

When the tip of the couple becomes worn away by continued use, a fresh portion is exposed to the molten metal and the reading will be the same as if the couple had not been reduced. A separable junction is provided, as shown in the diagram, so that fresh tips can be conveniently applied before enough of the couple has worn away


LEADS TO INSTRUMENT
EXTENSION OF COUPLE
PATENTED SEPARABLE JUNCTION
PATENTED THERMO-ELECTRIC COUPLE
PORTABLE INDICATING INSTRUMENT
CRUCIBLE OF MOLTEN METAL

to appreciably affect the resistance and cause an erroneous indication on the instrument. These instruments are being successfully used by a large number of manufacturers. They are manufactured by Wm. H. Bristol, 45 Vesey Street, New York City.

Humidifying and Cooling in Textile Mills.

THE subject of cotton conditioning has long been one of vital interest to all mill operators. This subject was well treated by Mr. W. H. Carrier, M.E., of the Buffalo Forge Co., Buffalo, in a paper which he read before the annual convention of the American Association of Cotton Manufacturers at Philadelphia recently. The main purpose of this address was to show both the scientific principles applying to the artificial conditioning of cotton mills and to describe a system of conditioning which would embody such principles most effectually. The system described is a fan system and has been entirely successful in meeting the widely different sets of conditions during cold, and hot, dry weather. It humidifies and cools in summer by artificial ventilation with cold saturated air and humidifies and heats in winter by first saturating the air at proper temperature and then heating air after saturation to a temperature sufficient to maintain the required temperature and humidity conditions in the room. The apparatus consists of a humidifier, fan and heater and a system of ducts for the distribution of the humidified air. The humidifier consists of a large air chamber in which spray is atomized under high pressure by means of a large number of cyclone nozzles. The air is thus filled with an extremely fine mist in large volume and thereby brought to the point of saturation. The free moisture is then separated from the air by an eliminator. The design of the latter and of the spray nozzle are the two principal features which make this apparatus a success. The construction of the nozzle is such that it is practically impossible to clog it with foreign material, the smallest hole being 3/32 of an inch in diameter, yet it throws a perfectly atomized mist by reason of the centrifugal principle upon which it operates. The very difficult function of separating this finely atomized spray from air current at high velocity is performed by an eliminator of special design. The fan and heater are of unusual design and need no special mention —the only variation from the standard being that the air is by-passed around the heater during the summer, thereby avoiding the frictional resistance of the same.

The Buffalo system may be easily applied to a fan system already installed. The size of fan ordinarily used is insufficient to care for summer conditions and the apparatus can be successfully operated only during cool weather. Old plants, however, can easily be remodeled by the installation of a larger fan and putting in additional ducts. A considerable advantage in employing this method of heating is that it avoids a great amount of piping strung along the ceiling which is not only inefficient in heating but catches dust and lint which eventually drops off and causes unequalities in the yarn. The principal advantages of the system are: that it humidifies and cools the air before, not after entering the room; non-dependence on uncertain and insufficient air leakage in and out of the mills for cooling effect; humidified and cooled air delivered to work rooms under slight pressure so as to avoid drafts. Inward leakage of hot air in summer and of cool dry air in winter are thereby prevented, an essential feature for uniform humidity and temperature conditions. The rooms are cooled without opening the windows in summer, thereby avoiding window drafts, disastrous to fine yarns. The one system cools the spinning room within 5° of outside temperature in summer, insures uniformly heated and regulated temperature in winter, maintains and controls the humidity in all parts of the mill at a desired degree both winter and summer. The apparatus is located centrally, permitting each department to be controlled from one point at the apparatus or at each room as preferred. One man can easily care for the entire humidifying, cooling and heating equipment.

The Buffalo Forge Company will cheerfully furnish this address in its entirety to any who are interested and any other information on this apparatus, which may be desired.

News Supplement

The Engineering Magazine—August, 1907

Personals.

—The Under-Feed Stoker Co. of America, Chicago, announces a change in its official directorate whereby Fred A. Daley, heretofore Treasurer and Manager of the Company, becomes President and Treasurer.

—Messrs. Maurice Gesundheit and Henry Osgood have entered the unique field of manufacturing engineers and business methodizers. The firm's name is Gesundheit-Osgood Company, with offices at 43 Cedar St., New York.

—Oscar Winter, who for more than six years has been steam expert of the National Tube Company, formerly the Lorain Steel Co. of Lorain, O., has opened a consulting office in the Rockefeller Building, Cleveland, O., where he will give special attention to expert work in steam engineering.

—Announcement is made of the appointment of William D. Ennis as Professor of Mechanical Engineering in the Polytechnic Institute of Brooklyn. Professor Ennis, who is most widely known through his contributions to the technical press, is a graduate of the Stevens Institute and from 1901 was engineering adviser to various Rockefeller interests in the Northwest and elsewhere, including the American Linseed Co. Since 1905 he has been exclusively engaged on special power investigations for the American Locomotive Co.

Industrial Notes.

—B. F. Sturtevant Co., Boston, have recently sold a large equipment of their electric propeller fans for export to Yokohama.

—The Buffalo Forge Co. have changed their Pittsburg office from 1101 Diamond Bank Building to 613 House Building. E. P. Leadbetter is manager.

—The Sprague Electric Co., New York, has opened a district office in the Hennen Building, New Orleans. This office is under the management of F. V. L. Smith.

—Dodge & Day, engineers and constructors, Philadelphia, have commenced work on an extension of the York, Pa., Street Railway system, from York to Hanover.

—The Boston branch of The American Mfg. Co. has outgrown its original quarters in the Post-office Square Building and taken larger offices in the Ames Building. W. F. Morgan is manager of the Boston office.

—The Western Electric Co. has put in at 230 Lee Street, Atlanta, Ga., a complete stock of general electrical supplies, and at that point had established a supply organization to care for the Southeastern trade.

—The Power Specialty Co., New York, report recent sales of 120 Foster superheaters, aggregating 42,000 H.P. These superheaters are to be installed in B. & W., Stirling, Edge Moor, Heine, Franklin, Atlas and other boilers, including a number of return tubular boilers.

—A system of drying belting is being installed for tne Rossendale & Reddaway Belting & Hose Co., Newark, N. J., by the B. F. Sturtevant Co., Boston. The equipment consists of a large fan with steam heater through which air is drawn, heated, and forced through ducts to the desired points.

—Bucyrus Co., So. Milwaukee, has just issued an elaborately illustrated reprint of President Roosevelt's message on the Panama Canal, transmitted to Congress under date of December 17, 1906. This company has furnished all the steam shovels ordered by The Isthmian Canal Commission up to May 1, 1907.

—The Hercules Special, the new machine recently put upon the market by the Century Machine Co., Rochester, is meeting with success. This machine is smaller than the regular Hercules, but is built exactly the same. It was put out to meet the demand for a smaller machine and will make blocks from 2 inches up to 32 inches in length.

—The Bristol Co., Waterbury, Conn., are distributing a bulletin entitled "Power Economy" by H. P. Dennis, M.E., treating of power plant equipment. Mr. Dennis is recognized as an authority on this subject. The Bristol Company will be pleased to send copies of this bulletin to interested parties.

—The new buildings for S. L. Allen & Co., Philadelphia, which are being designed and constructed by Messrs. Dodge & Day, are progressing rapidly. These buildings are being constructed entirely of reinforced concrete and the centering has already been removed from the two lower floors so that the buildings will soon be ready for the installation of machinery.

—Kitts Manufacturing Co., Oswego, N. Y., has increased its capital stock from $40,000 to $100,000 for the purpose of enlarging its facilities for meeting the increased demands for the steam specialties made by this company. The Hunter Fan & Motor Company of Fulton, N. Y., have acquired an interest in this firm, and a new plant will be erected this fall.

—Mechanical draft for boilers is being installed by the B. F. Sturtevant Co., Boston, for Kitson Machine Shops, Inc., Lowell; R. B. Whitacre & Co., St. Paul; State Hospital, Morganton, N. C.; Bemis & Call, Springfield, Mass.; General Chemical Co., Dundee, N. J.; General Chemical Co., Laurel Hill, L. I.; Lovegrove & Co., Inc., Philadelphia; and International Paper Co., Otis Mill, Chisholm, Maine.

—Among sales of recent date made by the Under-Feed Stoker Co. of America, Chicago, are two of considerable importance effecting the textile industry. The Amoskeag Mfg. Co. has placed an order for 28 Jones stokers, making a total of an even 100 Jones stokers purchased by that company and its allied interests. The York Mfg. Co., Saco, Me., has contracted for an additional 12 stokers which will make a total of 33 Jones stokers in their plant.

—J. H. Wagenhorst & Company, Youngstown, Ohio, manufacturers of electric blue printing machines, report the following partial list of sales: Cleveland Crane & Car Co., Wickliffe, O.; Warren Steam Pump Co., Warren, Mass.; Vulcan Iron Works, Detroit; A. O. Smith Co., Milwaukee; Traylor Engineering Co., New York; John S. Cole, Charleston, W. Va.; Carnegie Steel Co., Youngstown, O.; District Pumping Station, Washington, D. C.; C. P. & E. R. R. Co., Willoughby, O.; Eugene Dietzgen Co., Chicago; Pardee Bros. & Co., Lattimer Mine, Pa.; Tennessee Coal, Iron & R. R. Co., Bessemer, Ala.

—Anderson Forge & Machine Co., Detroit, was organized one year ago last February and since that date have been adding to their equipment as fast as they could secure shipment of the machinery and have about completed the installation of their additional equipment for manufacturing drop forgings, crank shafts and tools. The plant is now equipped with 21 hammers of various styles and sizes enabling them to manufacture a large range of drop forgings for machinery and automobile manufacturers. They have erected a new building for a die room 40′ x 150′, two stories high, of heavy construction. This building was especially designed for die making and have also installed a new steam hammer which enables them to do a considerable amount of large general forging, and their machine shop equipment is especially arranged for the manufacturers of engine crank shafts.

—The New York State Steel Co., Buffalo, after a thorough trial of a 4,000 H.P. We-Fu-Go water softening and purifying system manufactured by Wm. B. Scaife & Sons Co., Pittsburgh, have placed an order with them for another 4,000 H.P. system to be added to their present system, making a total of 8,000 H.P. Other sales reported by Wm. B. Scaife & Sons Co. are:—The Andrews Steel Co., Newport, Ky., 3,750 H.P. We-Fu-Go system; National Home for Disabled Volunteer Soldiers, Dayton, one 300,000 gallon per 24 hour We-Fu-Go system, two 1,200 gallon per hour We-Fu-Go systems; American Sheet & Tin Plate Co., Pittsburgh, 5,000 H.P. Scaife system; Rochester & Pittsburgh Coal & Iron Co., DeLancey, Pa., 1,500 H.P. We-Fu-Go system; Youngstowns Sheet & Tube Co., Youngstown, 15,000 H.P. We-Fu-Go system; Pennsylvania Salt Mfg. Co., Natrona, Pa., 5,000 H.P. We-Fu-Go system; Norwalk Iron & Steel Co., Norwalk, O., 1,000 H.P. We-Fu-Go system; McConway & Torley Co., Pittsburgh, 1,000 H.P. We-Fu-Go system.

NEW CATALOGUES AND TRADE PUBLICATIONS

Note—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page II.*

Boiler Tube Cleaners.

Vulcan Soot Cleaner Co., Du Bois, Pa.—Well printed catalogue illustrating and describing this company's methods and apparatus for eliminating a great waste in operating all types of water-tube and return tubular boilers. Also contains numerous testimonial letters and partial list of users. 6 by 9 in.; pp. 32.

Box-Car Loaders.

Christy Box-Car Loader Co., Des Moines.—Catalogue devoted to an illustrated description of box-car loaders for loading coal, ore or other minerals into box or stock cars. 7 by 9½ in.; pp. 42.

Concrete Forms.

Universal Form Co., New York.—Pamphlet illustrating and describing steel clad, self-aligning forms for monolithic concrete construction. 6 by 9 in.; pp. 16.

Concrete Industrial Plants.

Balliger & Perrott, Philadelphia.—Catalogue illustrating some examples of reinforced concrete industrial plants and business buildings recently constructed by this company, together with brief descriptions of the systems of construction. 6 by 9 in.; pp. 48.

Crushing Machinery.

Krom Machine Works, New York.—Catalogue treating of crushing machinery, together with dimensions, capacities and prices. Illustrated. 6 by 9 in.; pp. 26.

Dump Cars.

Continental Car and Equipment Co., New York.—Catalogue E devoted to an illustrated description of dump cars for railways, sand pits, brick yards, phosphate plants and contractors engaged in the removal of large quantities of earth, rock, sand, gravel, etc. 9 by 6 in.; pp. 32.

Electrical Equipment.

General Electric Co., Schenectady, N. Y.—Bulletins Nos. 4493-8-9, 4502-3-7-8-9-10-11-14 and 15 illustrate and describe controllers, wattmeters, rheostats, switches, generator sets, flat irons for laundry work, motors, train lighting, rheostat switches, lightning arresters, indicating instruments, and cylinder controllers respectively.

Feed Water Heaters.

Marion Incline Filter & Heater Co., Marion, O.—Catalogue illustrating and describing the Marion system of feed water heating and purification. 6 by 9 in.; pp. 30.

Feed-Water Heaters.

Harrison Safety Boiler Works, Philadelphia.—Booklet concisely summarizing what a Cochrane feed-water heater is. Examples are given of practical applications at coal mines, paper mills, in condensing and non condensing plants, and in steam power plants generally. Illustrated. 6 by 9 in.; pp. 8.

Filters.

Blaisdell Co., Los Angeles.—Catalogue G illustrating and describing pressure filters. 6 by 9 in.; pp. 12.

Gas Producers.

Forter-Miller Engineering Co., Pittsburg.—Catalogue treating of the Forter water sealed gas producer. Illustrated. 9 by 12 in.; pp. 62.

Generator Valves.

Lunkenheimer Co., Cincinnati.—Booklet, printed in two colors, illustrating and describing several types of generator valves designed to meet various requirements, together with a price list. 3½ by 6 in.; pp. 24.

Heating Furnaces.

Rockwell Engineering Co., New York.—Pamphlet illustrating bolt and rod heating furnaces that may be operated with oil or gas fuel. 6 by 9 in.; pp. 8.

Lathes.

Gisholt Machine Co., Madison, Wis.—Well-printed catalogue illustrating and describing turret lathes, boring mills and tool grinders. 8 by 10 in.; pp. 16.

Machinists Tools.

Brown & Sharpe Mfg. Co., Providence.—Catalogue containing an illustrated description, together with prices, of pocket scribers, spacing attachment, center punches, combination caliper and divider, micrometer caliper sets and steel rules with holders. 6 by 9 in.; pp. 8.

Mechanical Draft.

Green Fuel Economizer Co., Matteawan, N. Y.—Bulletin No. 108 containing an illustrated description of mechanical draft apparatus. 6 by 9 in.; pp. 16.

Pipe Flanges.

American Spiral Pipe Works, Chicago.—Catalogue describing forged and rolled steel pipe flanges, special forgings, and full size cross sections of flanges used in the different standards. Also contains tables giving sizes, prices, etc. The catalogue is well printed and illustrated. 8 by 10½ in.; pp. 94.

Pneumatic Hammers.

Ingersoll-Rand Co., New York.—Bulletin No. 2010 contains an illustrated description of pneumatic hammers. 6 by 9 in.; pp. 24.

Oil Filters.

Standard Gauge Mfg. Co., Syracuse.—Booklet illustrating and describing oil filters. Also contains tables giving dimensions, capacities, and prices. 6 by 3½ in.; pp. 12.

Recording Voltmeters.

Bristol Company, Waterbury, Conn.—Bulletin No. 57 illustrating and describing recording voltmeters for use on either direct or alternating current regardless of the rate of alternations. 8 by 11 in.; pp. 4.

Regulators.

Locke Regulator Co., Salem, Mass.—Catalogue M illustrating and describing regulating devices for the conduct and control of steam and water pressure, together with price list. 6 by 9 in.; pp. 56.

Sand Pump.

J. H. Frenier & Son, Rutland, Vt.—Catalogue illustrating and describing sand pumps for pump-

No. 6 pages 31-39

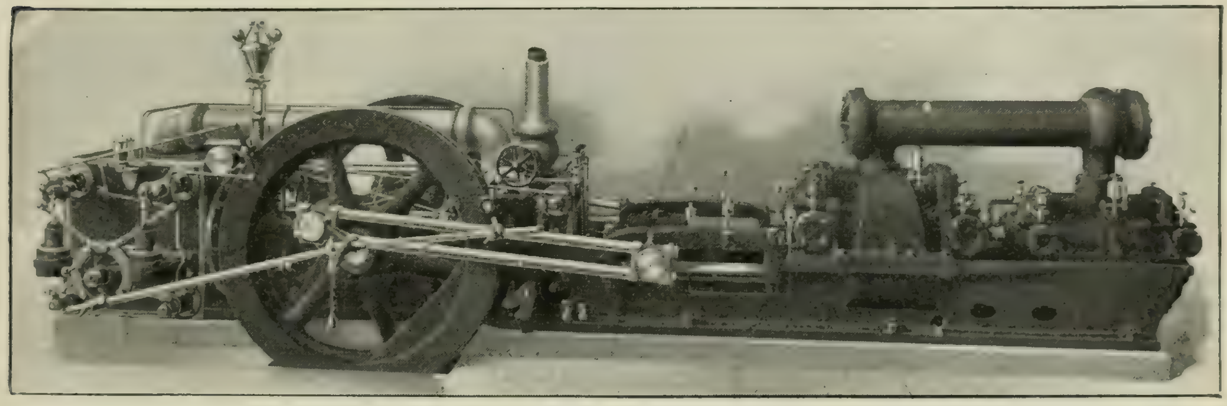
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A Straight Line Corliss Air Compressor.

ENGINEERS recognize in the Corliss engine the most economical means of compressing air by steam power. In the cross-compound type one horse power may be produced on from 14 to 16 pounds of feed water per hour when running condensing, or 20 to 23 pounds non-condensing. But the price of the Corliss unit appears large to many operators, even in regions where the cost of the fuel saved would pay for the entire machine in a short time. Slide valve compressors are, therefore, often installed. The development of an air compressor combining high steam economy with moderate price has advanced but slowly. In some cases the principles of good mechanics have been distorted to the sacrifice of durability, ease of action and mechanical efficiency, in order to reduce construction costs; in other words, various substitutes for the full Corliss valve gear have been offered. It is conceded that some of these compromise machines may fairly claim a certain degree of economy in operation, and that when a test is made under ideal running conditions they make a good showing as compared with a Corliss compressor. The conditions of every-day operation, however, are not once in a hundred like those prevailing in a test. In one case the steam pressure, air pressure and speed are all constant, while in the other the fluctuation in any or all of these factors is likely to be extreme. Sometimes these extremes oppose one another, or they may be high or low together. It is on account of this fluctuation that the Corliss compressor uses so much less coal in the course of a day's run. Its valve gear brings the cut-off in the high and low pressure steam cylinders under the automatic regulation of the governor. There is no wire-drawing of the steam, nor is there throttling action at any time.



A compressor has been designed by S. T. Nelson, mechanical engineer with the Sullivan Machinery Company, which embodies the economy of the Corliss cross-compound type in a form which permits moderate price without the sacrifice of good engineering. The new machine, known as the "Class WO," is described as a "tandem compound steam, two-stage air, Corliss straight line compressor." To put it differently, tandem compound steam cylinders with full Corliss valve gear on both have been attached to the fly-wheel end of the standard Sullivan two-stage straight-line compressor, the high pressure steam cylinder occupying the same position as the single Meyer valve cylinder of the "WB-2" machine. The high pressure steam cylinder is of special design, to make room for the Corliss valve bonnets and dash pots between the cylinder and fly-wheels, and to do this the steam chest is offset to one side. The dash pots for closing the steam valves are set directly on the main frame and the motion rods for operating the exhaust valves are arranged in the usual way, except that they are longer. Back bonnets are provided as usual, and the frame is so designed that either one or all of the steam or exhaust valves may be removed without disturbing the valve setting. The low pressure steam cylinder is attached to the end of the frame by means of rigid distance pieces. The bottom feet of this cylinder are on the same level with the bottom of the main frame and its weight is supported by an extension of the foundation. Practically the same pattern is used for making this cylinder that is used for the Sullivan cross-compound Corliss machines. It embraces all of the regular valve gear usually furnished with the latter type of machine.

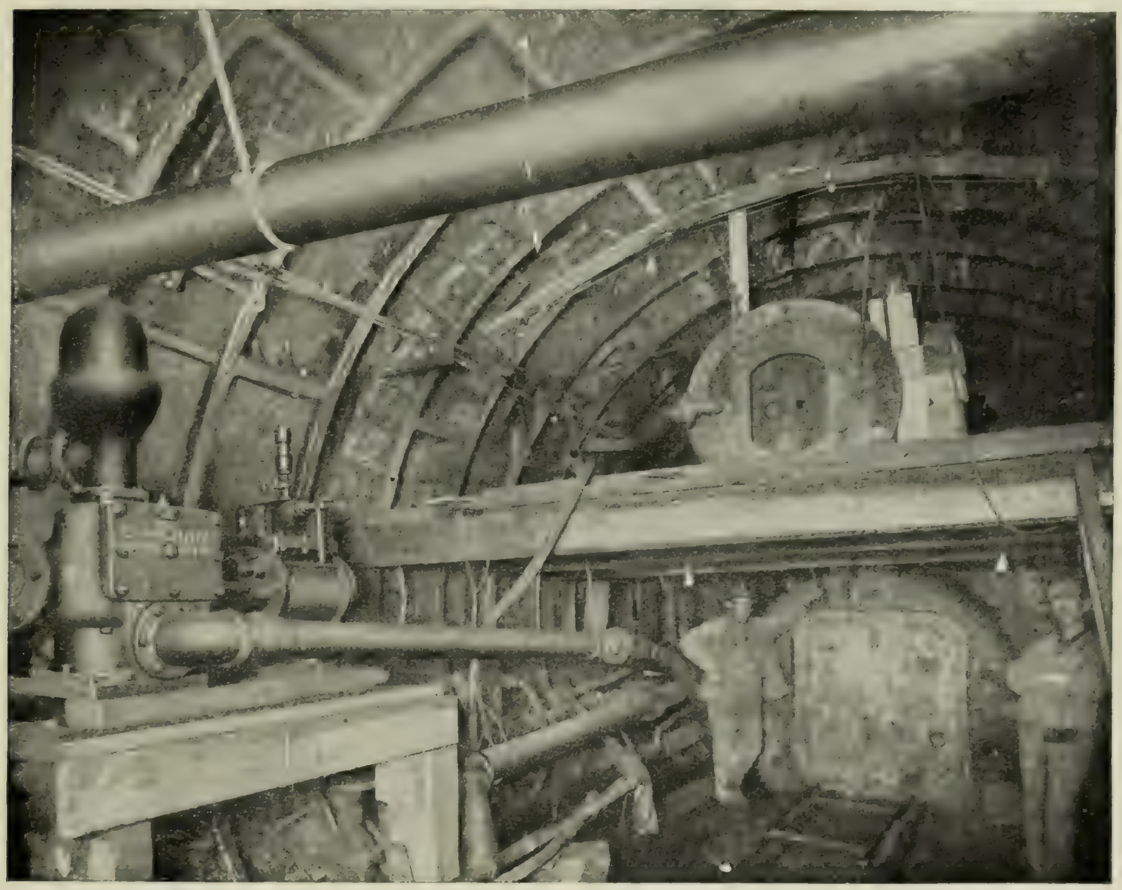
There are no adjustments between the fly-wheels and the steam cylinders to require attention while the compressor is in operation. The piston rod stuffing boxes are packed with fibrous metallic packing, which needs only occasional care. The main bearings and other parts which cannot be oiled by hand running, are lubricated by a system of pipes leading from a cluster of oilers mounted at a convenient point, so that the engineer can tell at a glance when one of them is empty. The eccentrics for operating the valve gear on both the high pressure and low pressure steam cylinders are placed on the crank pin on the outside of the fly-wheels, so that they are easily accessible. The eccentrics, rocker arms, valve stems and all connections between the fly-wheels or between the main bearings on the "WB-2" type are dispensed with in the "Class WO." The governor pulley is all that is placed on the shaft in their place. The removal of these parts allows the use of two piston rods between the high and low pressure steam cylinders, which are necessary to straddle the crank shaft, which is kept in its original position in line with the cylinders. The governor is on a separate mounting and is a combined speed and pressure regulator. In appearance, it is of the Corliss fly-ball type, but it is operated in unison with the pressure attachment. The exhaust steam from the high pressure cylinder is carried around the outside of the cylinder barrel to the top by a passage cast with the cylinder, and discharges into a covered receiver pipe extending from the top of the high pressure to the top of the low pressure cylinder.

From the standpoint of air efficiency this compressor takes the high rank of the class WB-2 machine. The inlet valves on both low and high pressure cylinders are of the semi-rotary pattern, positively driven by motion rods from an eccentric pin on the engine fly-wheel. The action of these valves permits the cylinder to fill itself completely at each stroke with air at the temperature of the atmosphere, and there is no wire-drawing or leakage. The discharge valves are of the automatic poppet type, so arranged as to reduce clearance losses to a minimum. The valves and their seats are removable by hand, so that the maintenance of a perfect fit is a simple matter. The ideal of isothermal compression is approximated in these machines by means of unusually adequate cooling apparatus. This consists of heavy water-jackets on the air cylinders, and an inter-cooler of ample proportions, containing copper water tubes, across which the air must pass several times in its course from the intake to the discharge cylinder.

The "Class WC" compressor is built very substantially, being self-contained on its heavy frame and on the distance pieces connecting the two steam cylinders. These parts are sufficiently massive to sustain the low pressure cylinder of themselves, without the aid of foundations if such a necessity should arise. The straight-line type unites with its advantages of engineering excellence, the features of low weight, simplicity, and minimum foundations, as compared with duplex machnes. These qualities render it possible to sell these compressors at a comparatively low price, to transport them readily and at small expense, and to erect them without elaborate and costly preparations at the desired site. They are built at present in sizes ranging from 909 to 2,450 cubic feet of free air per minute.

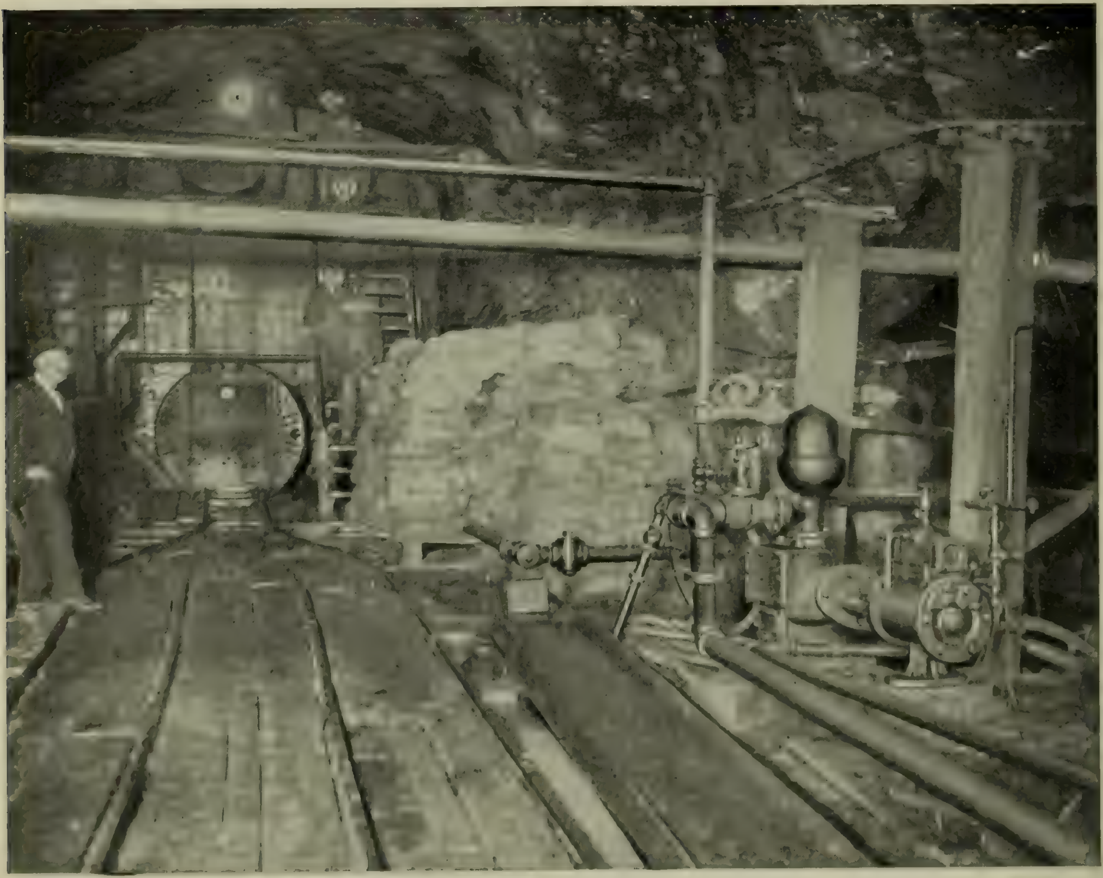
The Belmont Tunnel.

RAPID progress has been made on the Belmont tunnel now being constructed under the East River, New York. This tunnel and subway is more than three miles in length, extending from Park Avenue and Forty-second Street, Manhattan, to Jackson Avenue and Fourth Street, Long Island City, and will afford easy and quick transit between the boroughs of Queens and Manhattan, connecting with the Interborough system of subways, near the Grand Central Station.



The first shaft was started July, 1905, and the work has been rushed night and day ever since, and it is expected that both tubes will be completed and in full operation the latter part of this year. This tunnel consists of two parallel tubes, each arranged for single tracks. Parts of the tubes are horse-shoe shaped, while under the river bed they are circular and built of sectional cast-iron rings, all substantially made and safe to a degree far in excess of what is required to carry the heavy electric trains.

The Degnon Engineering and Construction Company are the builders of this tunnel, and have a complete equipment for handling the work and are using the most modern methods. There are five shafts or entrances to the tunnel: two on the Manhattan side, two on the Long Island City side, and a shaft in the centre of the East River on Man-o'-War Reef. The latter is on a coffer-dam built in the river by the contractors with the Government's permission. Parts of the tubes were driven by the single bench method under atmospheric pressure; but under the river bed the shield method was substituted and the subaqueous tubes were continued by the shields, cutting their way forward and pushed by the hydraulic jacks operated by compressed air. The shields are 15½ feet in diameter, the exact size of the cast-iron shells which are set in place and bolted together. Compartments or airlocks are formed between the shields and the finished tunnel by steel bulk heads, and the pneumatic pressure, which is maintained equal to the hydrostatic pressure at the center line of the tubes, holds up the river bed and prevents the water from drowning out the workings. There is, however, an accumulation of water coming into the workings from the bottom of the tubes where the "sandhogs," so-called, are at work, and where the hydrostatic pressure is greater than the pneumatic pressure. The water is collected in temporary sumps constructed in the air-locks, and from there is forced out by the air pressure through the pipes to the various pumping stations that are situated along the line of construction. This method readily takes care of the water from the air-locks, but there is a constant seeping through joints where the calking has not been completed, as well as an accumulation of drainage water coming into the tubes.

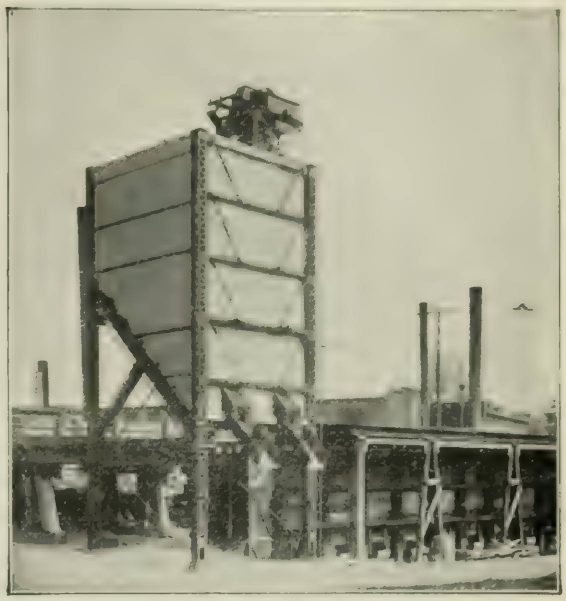


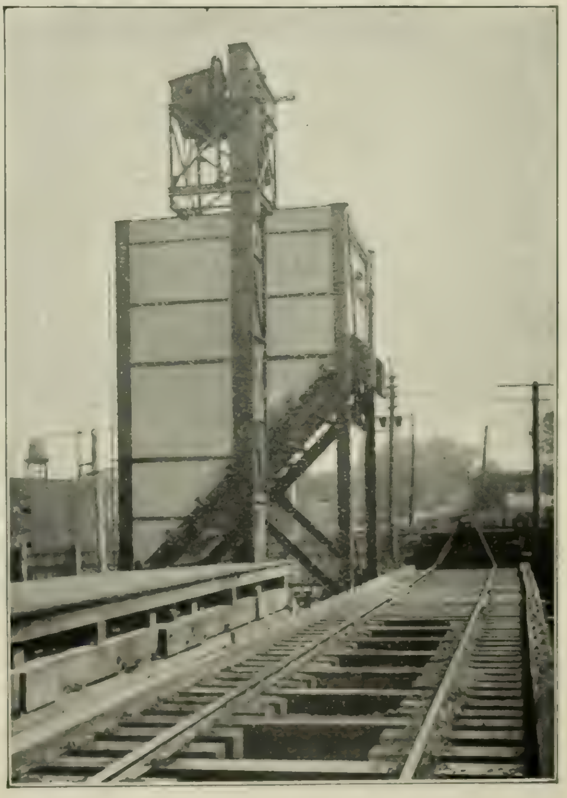
In several places the segments or wall plates have been removed and the rock and other material forming part of the 8 feet of partition between the two tubes were cut through to provide for the sump chambers and allowing room for the pumping stations. Where the pumps are situated alongside the tunnel walls and in the workings, no extra room was required for their installation, as they are all of the Cameron design, having the Cameron characteristic of compactness. Engineers have taken advantage of this type of pump for underground construction work on account of its having no outside valve gear and its entire absence of moving arms or levers to become broken or get out of alignment. These pumps are massive in construction to prevent injury from blasting, falling rock, and débris. They can be relied upon in case of sudden flooding into the excavation and caisson linings, and will work as well under water as above. In emergencies or accidents the normal capacity can be doubled, as occasionally occurs when they are run at a piston speed of over 200 feet per minute. A unique and simple device is attached to the pumps to keep the exhaust compressed air from freezing in the air cylinders. A small pipe is connected from the discharge water pipe to the exhaust openings on the air cylinder over which the spray from a ⅜-in. nozzle flows constantly while the pump is running; thus equalizing the temperature about the exhaust chamber and preventing freezing. This simple device also acts as a muffler on the exhaust, which would otherwise be deafening to the workers in these closed tubes.

Insurance Against Loss of Profits.

PROBABLY every reader of this magazine is familiar with fly-wheel insurance, which is similar to steam boiler insurance and covers the loss and damage resulting from the bursting or disruption of a fly-wheel. Not the least valuable feature of fly-wheel insurance is the inspection service which insurance companies furnish as a part of their policy. Many serious defects in the fly-wheel or engine are found, the timely correction of which by insurance company inspectors has prevented serious loss. In spite of the most careful inspection, however, fly-wheel accidents are of frequent occurrence, and when one does occur the property loss is usually very large. Another feature, however, which has heretofore been overlooked by insurance companies, is the loss of profits which results to the manufacturer from his inability to produce goods after his plant has been demolished by an exploding fly-wheel. Machinery cannot be replaced quickly. As a matter of fact it usually takes months to replace the mechanical equipment of a plant. When the machinery is of a special type or designed for a special purpose the delay, of course, would be much greater. This condition of affairs has caused the Maryland Casualty Company of Baltimore, Md., to issue what they call the "Use and Occupancy Endorsements," to be attached to their fly-wheel insurance policies. This endorsement provides for the payment of a specified indemnity during the inability of the plant to manufacture goods. The exact amount is arranged for in advance, and is based upon the average production of the plant during the three hundred days preceding. A noticeable feature of this endorsement is that the portion of the insurance applicable to the loss of profits indemnity is not deducted from the face value of the policy, but is a separate insurance, which the company pays in addition to the face value of the policy. We understand that there has been a great demand for this protection. The Maryland Casualty Company will be glad to furnish full information upon application.

Concrete Ash Bins.





THE accompanying cuts illustrate a reinforced-concrete ash bin and elevator, which were recently installed by The Jeffrey Manufacturing Company of Columbus, Ohio, at the power plant of the Knoxville Railway and Light Company, at Knoxville, Tenn., for handling the accumulation of ashes at their power plant. At this plant the ashes are handled in small push carts from boiler house to elevator, where they are dumped into a receiving hopper and elevated by means of an elevator of the chain and bucket type to a bin. This bin holds approximately 30 tons of ashes, and delivers its contents to railroad cars on a switch running alongside of the bin, through the bin gates and aprons. The elevator, which is 46 ft. centers, has a capacity of 12 tons per hour, and is operated by a 5 horse power motor connected to the head shaft of the elevator. The elevator being encased the entire length and delivering through a steel spout to the bin makes the equipment practically dust tight. Anyone interested in this class of equipment may receive full information concerning it by writing direct to the Jeffrey Manufacturing Company, Columbus, Ohio.

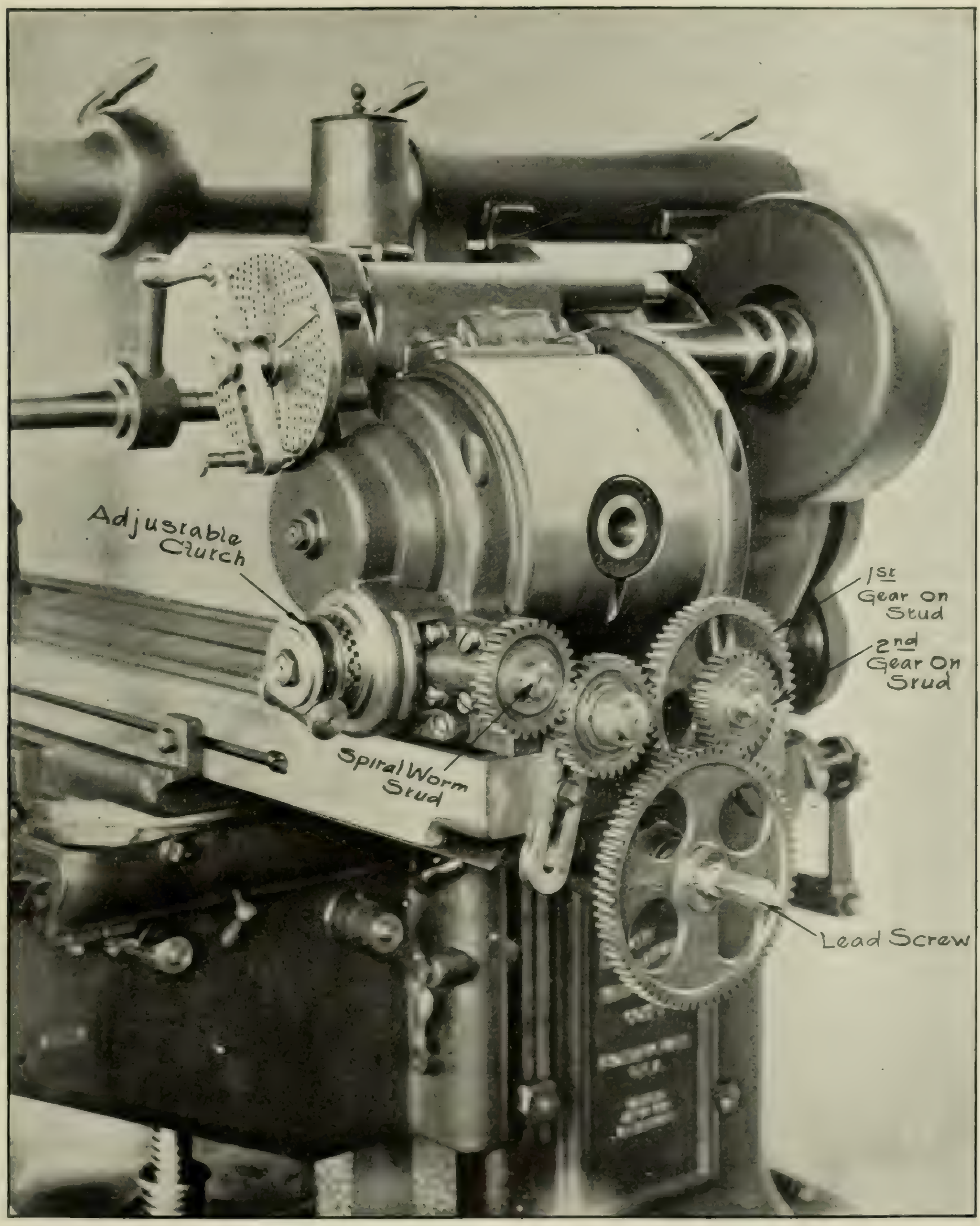
Universal Index and Spiral Head.

BECKER-BRAINARD Milling Machine Company, Hyde Park, Mass., have brought out a new universal index and spiral head. The points of special interest in this new head are its stiff and rigid construction; its large worm and worm wheel of coarse pitch; arrangement by which differential indexing may be accomplished regardless of the head's position on the machine platen; arrangement by which differential indexing may be accomplished on other than plain cylindrical work, such as bevel gears; arrangement by which differential indexing may be accomplished on work with helical grooves, such as spiral gears; arrangement by which the spindle and work may be rotated independent of the lead screw when the change gears are set for spiral milling; making the setting of the work much easier than it would otherwise be; the adjustable clutch for facilitating the last operation; the index crank with handle for rotating the same separate from the index pin, giving a crank of the same throw regardless of the position of the index pin and eliminating the danger of the pin dropping on the plate while revolving the crank; the single reversible index plate for all divisions; adjustable dial on the spindle nose for obtaining angular division in degrees for work requiring no great accuracy; means for taking up wear in worm gear or dividing wheel.

This head is the result of a desire to fill the need of a spiral head that will at once answer the requirements of the heavier duty now imposed on the milling machine and still retain the fine points of accuracy expected from such a tool. In designing this head it has been the object to produce a design that would answer the requirements of the wide range of work met with in ordinary practice without sacrificing any of the desirable features of the older heads, and to add those features that good practice shows would greatly increase the usefulness of the head on general work. The worm gear is made in two sections so that one section may be rotated on the other to take up the wear on the teeth. This method has long been used and is the most accurate method of adjusting for wear and also in the hobbing of the teeth in the blank. The stiffness and rigidity of the construction is shown plainly in the view. This increase in strength has in no way impaired the ease of handling nor made the head at all clumsy or awkward to operate. The design is of an approved type, having the swivel block housed between heavy uprights in which the block swings in a vertical plane. The block is held in any position by means of clamping bolts which draw the outside plates securely against the uprights, making a secure bind holding the head in position against the heaviest cuts.

The principal feature of the design is the large worm wheel that has been obtained. This gear has been made as large as the respective swing of each size head would allow, and by the design followed it has been made much larger than that of any head so far offered. This large diameter adds much to the life of the wheel and insures greater accuracy in the work than would be possible with the smaller diameter common to other dividing heads. The large diameter and resulting coarse pitch allows of much heavier spiral cuts being taken without the danger of impairing the accuracy or of distorting the teeth in the gear. The increase in stiffness of the head in general makes possible the taking of much heavier cuts at faster feeds and speeds, obtaining the best possible results with high speed steels.

In bringing out this new head the idea of making the differential indexing mechanism a component part of the head has been carried out so that the head may be used as an index or dividing head in any position along the platen with the spindle either parallel with or at right angles to the main spindle of the machine, or in any intermediate position. This has been accomplished by placing the change gears used in differential indexing on the rear side ot the head. The gears have no connection with the table at all as is the case with the ordinary index head fitted for differential indexing. With the gears used in differential indexing arranged on the head, as is done on this head, it is possible to swing the spindle into position for cutting bevel gears or teeth on any conical work. This at once broadens the scope of differential indexing from straight cylindrical work to that which requires the angular setting of the spindle in the vertical plane. In order that the application of the differential indexing may be universal, it is necessary that it be made available for use on work with helical or spiral grooves, such as spiral gears. It has been done in this new head.



NEWS SUPPLEMENT

The Engineering Magazine—September, 1907

Personals.

—J. Cecil Nuckols, for the past three years advertising manager of The S. Obermayer Co., Cincinnati, has recently received the additional appointment of advertising manager of The Cincinnati Electrical Tool Co.

—Mr. John C. Ostrup, M. Am. Soc. C. E., has been appointed to fill the Chair of Structural Engineering at the Stevens Institute of Technology, Hoboken, N. J.

Industrial Notes.

—Sullivan Machinery Co., Chicago, announce that their San Francisco branch is now located at 26-28 Fremont St. Howard T. Walsh, manager.

—Atlas Engine Works, Indianapolis, announce the appointment of Otto Dieckman, Jr., as manager of their direct sales office at St. Louis, with offices in the Chemical Building.

—The E. H. Mumford Co., Philadelphia, has assumed exclusive sales agency for the new French molding machines of Ph. Bonvillian & E. Ronceray, also of Philadelphia.

—Colné & Co., successors to Powell & Colné, New York, have just closed a contract with the Government for the installation of a steel casting equipment by the Tropenas converter steel process at the Mare Island Navy Yard, California.

—Parker Boiler Co., Philadelphia, report the following orders: Austin Mfg. Co., Harvey, Ill., 1 365 H.P. boiler; Southern Indiana Hospital for Insane, Evansville, Ind., 3 300 H.P. boilers; Perth Amboy Chemical Co., Perth Amboy, N. J., 1 267 H.P. boiler.

—The American Consul at Kingston, Jamaica, announces that he is installing a Catalogue and Reading Room, in which he will systematically arrange catalogues of American advertisers, trade journals, magazines, etc., and that he would be pleased to receive copies of catalogues issued by American manufacturers.

—"The Art of Cutting Metals" by Frederick W. Taylor, M.E., Sc.D., which was the Presidential address presented at the last annual meeting of the American Society of Mechanical Engineers, has been reprinted and bound in cloth by the Society. This or any other publication of the Society may be had by addressing the Secretary, 29 West 39th Street, New York.

—One of the most complete and modern lines of brass and iron specialties is shown in the catalog of The Wm. Powell Co., Cincinnati. This catalog presents their line in a most complete and practical manner, giving dimensions of every article for which a dimension may be required, and explaining in detail the merits of their well-known specialties. A valuable series of tables and rules is bound in with the catalog, giving in a concise form information that every engineer and shop manager requires in his daily practice. A copy will be sent free to interested parties.

—The Vredenburg Co., with an office at 1332 Monadnock Block, Chicago, is devoted to a consulting practice in engineering and general technical advertising, being the only concern of the kind in the West. This company is prepared to render careful and expert service to engineering, contracting and manufacturing companies, desiring intensification of their advertising, the changing of copy weekly, bi-weekly and monthly, and the preparation of dignified, attractive advertisements. The manager, Clarence Vredenburg, was editor and manager of *Engineering World* from its inception until its recent sale.

—The Isthmian Canal Commission has decided that the walls of the canal, where it passes through rock, shall be channeled. This includes almost all of the "wet prism" in the Culebra Division, nine miles long, and also the walls of the locks at La Boca and Mira Flores. The advantages to be gained from channeling are several. (1) The resulting wall is solid and unbroken by explosives. (2) The wall is cut exactly to the surveyed line—no subsequent trimming or filling is needed, as in the case of a wall cut by drilling and blasting. For this work the Commission has ordered from the Sullivan Machinery Co., Chicago, 24 class Y-8 channelers, fitted with air reheaters.

—The valuable results obtained by the United States Geological Survey at the St. Louis Exposition in determining the actual steam-making values of American fuels is to be continued with a similar plant at the Jamestown Exposition. The report on the St. Louis tests is devoted largely to fuels from the Middle West and Western coal fields. The plant now being erected at Jamestown will give an opportunity for analyzing, testing and placing on record in a similarly thorough and comprehensive manner the coals from the Eastern fields. The Jamestown plant will obtain three 300 H.P. boilers, each equipped with an engine-driven 100-inch mechanical draft fan and a 35-ft. stack both supplied by the Green Fuel Economizer Co., of Matteawan, N. Y. The fans will be so controlled that the draft can be regulated as desired by hand or automatically. The wheels of the fans measure 5 ft. in diameter by 2⅔ ft. width at the tips of the blades and are driven by 6 × 7-inch Green vertical center crank engines. The laying out of the mechanical draft plant was entrusted by the Survey to the Green Fuel Economizer Company.

—The Power Specialty Co., New York, announce the appearance of the fourth edition of its pamphlet on Superheated Steam, which has been revised by E. H. Foster, the inventor of the Foster superheater. This edition contains illustrations of superheaters manufactured by the company as applied to the various types of boilers in use in this country, and also of the direct fired type, ranging from large illustrations of 3,000 H.P. units to small portable superheaters, which may be used for experimental purposes. The pamphlet also contains reproductions of photographs of various parts showing the construction of the Foster superheater in detail, and a few pages are devoted to superheated steam specialties, such as piston rod packing, Harter flexible joints, corrugated bronze gaskets, and the Willits double acting non-return valve, all of which articles are sold by the company as being especially adapted to plants having superheated steam. At the back of the book are steam tables running to high pressures and temperatures, and tables of velocities of steam in various sizes of pipe at different degrees of superheat, and curves for readily selecting the proper size of steam pipe for any set of conditions, which will be found most useful to the designing engineer.

The introduction of the electric motor into modern methods of manufacturing has practically revolutionized many of our industries. The variety of uses to which the motor has already been put is one of the wonderful features of the present day's industrial operations, and yet its development appears to have only just begun. The absence of steam, dirt and smoke, the extensive elimination of the dangerous belt, as well as the greater economy of electric power over steam, are some of the causes which are making the ascendency of the "electric drive" so phenomenally rapid. So important has this work become that the larger electric companies have a special department, which takes care of the work of electric motor power production. Taking, for example, some of the orders which the Westinghouse people have taken in this field since the first of June, the variety of the use of the motor becomes evident. The East Pittsburg works are now turning out sixteen locomotives for coal mines in West Virginia and Kentucky, one for an iron mine in Sweden, another for a power company in the State of Washington, and one for a plate glass mill at Charleroi, Pa. They are constructing a complete electric motor equipment for a phosphate mine in Florida, for a lumber camp at Mount Pleasant, Pa.; they have in hand an order for 39 motors to drive machinery in a cash register manufacturing plant at Dayton, O.; they are turning out 59 motors for driving textile looms at East Hampton, Mass., and a larger number for running spindles in a worsted mill at Passaic, N. J. Fifteen motors are going to a paper mill in Canton, N. C., and twenty to a paper mill in Fulton, N. Y.

NEW CATALOGUES AND TRADE PUBLICATIONS

Note—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page 11.*

Adding Machine Carriage.

Eureka Adding Machine Carriage Co., Detroit.—Leaflet containing a brief illustrated description of adding machine carriages, together with a list of recent purchasers. 6 by 9 in.; pp. 6.

Ball Bearings.

Bantam Anti-Friction Co., Bantam, Conn.—Catalogue illustrating and describing ball and roller bearings of all types. 6 by 9 in.; pp. 46.

Blue Printing Machines.

Buckeye Engine Co., Salem, Ohio.—Booklet containing a copy of a speech on The A B C of Blue Printing delivered by Prof. A. C. Tinic before The National Federation of Blue Printers. 4¼ by 6½ in.; pp. 20.

Bronze Bearings.

Lumen Bearing Co., Buffalo.—Well-printed and illustrated catalogue treating of the numerous uses to which Lumen bronze bearings may be adapted. 6 by 9 in.; pp. 32.

Coal Puncher.

The Pneumelectric Machine Co., Syracuse.—Well-printed catalogue illustrating and describing an electric coal puncher. 7½ by 9½ in.; pp. 24.

Coal Storage.

Dodge Coal Storage Co., Philadelphia.—Catalogue No. 70 contains illustrations showing some recent installations for the handling and storing of coal and ore, together with brief descriptions of each. 6 by 9 in.; pp. 112.

Concrete Bridges.

National Bridge Co., Indianapolis.—Well-printed catalogue illustrating and describing some of the reinforced concrete bridges recently erected by this company. 6 by 9 in.; pp. 96.

Concrete Machinery.

McKelvey Machinery Co., Cleveland.—Catalogue containing an illustrated description of batch concrete mixers, continuous and hand power mixers, concrete buckets, contractors' machinery, industrial cars, etc., together with tables giving capacities per hour. 9 by 6 in.; pp. 40.

Concrete Piles.

Simplex Concrete Piling Co., Tacony, Philadelphia.—Catalogue containing an illustrated description of concrete piles for foundations, wharves, trestles, reservoirs, etc. 6 by 9 in.; pp. 86.

Drafting Room Furniture.

Fritz & Goeldel Mfg. Co., Grand Rapids, Mich.—Catalogue and price list illustrating and describing drafting tables, drawing and training school tables and drafting room and office furniture. 7 by 5 in.; pp. 32.

Electric Hoists.

General Electric Co., Schenectady, N. Y.—Bulletin No. 4518 illustrates and describes the numerous applications of electric hoisting machinery and gives an outline of the work they are now doing in this field. Bulletin No. 4504 is devoted to an illustrated description of the G. E. Tungsten lamp for street series lighting and outlines briefly its importance to the central station.

Electric Pyrometers.

Wm. H. Bristol, New York.—Catalogue No. 17 contains an illustrated description and classified price lists of different classes and styles of low resistance pyrometers, both for indicating and recording all ranges of temperature up to 3,000° F. 9 by 12 in.; pp. 42.

Emery Wheels.

Star Corundum Wheel Co., Ltd., Detroit.—Illustrated catalogue describing emery and corundum wheels, grinding machinery and sharpening devices, together with price list. 6 by 9 in.; pp. 102.

Feed Water Filter.

James Beggs & Co., New York.—Catalogue describing the Blackburn-Smith feed water filter and grease extractor for the removal of organic matter, sediment, lubricating oils, etc., from boiler feed water. Illustrated. 6 by 9 in.; pp. 16.

Fire Brick.

Garden City Sand Co., Chicago.—Well-printed booklet describing fire brick. Illustrated. Also contains special information on fire brick for specifications. 4½ by 7 in.; pp. 28.

Furnace Grates.

Kelly Foundry & Machine Co., Goshen, Ind.—Catalogue K contains a brief illustrated description of dumping, rocking and stationary furnace grates. 9 by 6 in.; pp. 20. Catalogue F treats of boiler fronts. Also contains tables giving dimensions, weights and prices. 4½ by 7 in.; pp. 52.

Furnaces.

Hawley Down Draft Furnace Co., Chicago.—Catalogue devoted to an illustrated description of the Hawley Down Draft Furnace. Also gives the results of many tests made. 10 by 7 in.; pp. 16.

Gas Engines.

Abenaque Machine Works, Westminster Station, Vt.—Catalogue containing an illustrated description, together with numerous testimonial letters. 9 by 6 in.; pp. 20.

Gold Dredges.

New York Engineering Co., New York.—Pamphlet containing a treatise on dredges and gold dredging. Illustrated. 6 by 9 in.; pp. 20.

Grindings Wheels.

Norton Company, Worcester, Mass. — Well-printed catalogue illustrating and describing grinding wheels made of alundum and grinding machinery, together with price list. 6 by 9 in.; pp. 146.

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